## Contents

Graduate Programs ........................................... 3  
Graduate Study at the  
  University of New Hampshire ......................... 5  
Admission and Registration ............................... 7  
Fees and Financial Aid .................................. 13  
Academic Regulations and  
  Degree Requirements ................................ 19  
Research ..................................................... 23  
Graduate Life ............................................... 29  
Departmental Requirements and  
  Course Descriptions .................................. 34  
Trustees, Administrative Officers, and  
  Graduate Council ..................................... 115  
Faculty of the Graduate School ....................... 116  
Graduate School Calendar 1993–1995 .................... 125  
Index .......................................................... 128

---

The University of New Hampshire is a public institution with a long-standing commitment to equal opportunity for all. It does not discriminate on the basis of race, color, religion, national origin, sex, sexual orientation, age, veteran’s status, or handicap, in admission or access to, or treatment or employment in, its programs or activities. Inquiries regarding discrimination should be made to Chris Burns-DiBiasio, Affirmative Action Director, Room 305, Thompson Hall, (603) 862-2930, or to the regional director, Office for Civil Rights, Department of Education, J. W. McCormack P.O.C.H., Room 222, Boston, MA 02109-4557.

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 through the Affirmative Action Office, Room 305, Thompson 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 Office of Career Services, 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.
Graduate Programs

Master of Arts
Counseling
Economics
English
  Language and Linguistics
  Literature
  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
  Marriage and Family Therapy
Genetics
Hydrology
Mathematics
Mechanical Engineering
Microbiology
Music Education
Natural Resources
  Environmental Conservation
  Forestry
  Soil Sciences
  Water Resources
  Wildlife
Nursing
Ocean Engineering
Physical Education
Physics
Plant Biology
Resource Administration and Management
Resource Economics
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

Master of Occupational Education

Master of Business Administration

Master of Health 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
Education
Engineering
English
Genetics
History
Mathematics
Mathematics Education
Microbiology
Natural Resources
Physics
Plant Biology
Psychology
Reading and Writing Instruction
Sociology
Zoology

*No longer accepting applications
"My current project deals with testing soils that would be used for earthquakes or off-shore structures. We're doing a materials characterization of sands to know if you're building on this type of sand, what you need to expect when you get an earthquake. We're essentially looking at a new method for testing sands using a testing device, called a direct simple shear machine.

"What we'll be doing is measuring the shear wave velocity and correlating that with soil strength. We'll be able to take both acoustical and mechanical measurements—all on the same sample—and that's something unique about our research. We'll be able to look at how the strength increases over time. One of the problems this research might eventually address involves construction sites where the soil has been densified by blasting and initially loses much of its strength. By modeling that situation here in the lab, we may be able to show builders that from the disturbed condition, the soil strength will pick up twenty percent within thirty days and then level off. That way they won't have to wait some arbitrary time limit to begin building."

Heather Miller
Ph.D. student, Engineering
The University

The University of New Hampshire is a land-grant institution made possible by the Morrill Act of 1862, which helped states develop institutions to better serve all the people. The institution was originally founded in 1866 in connection with Dartmouth College as New Hampshire College of Agriculture and the Mechanic Arts. At that time, the school’s mission was to train young men and women for service to the state in the fields of 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. 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.

In 1980, UNH and the University of Maine were designated jointly as a Sea Grant College by the National Oceanographic and Atmospheric Administration (NOAA). In 1991, the University was designated a Space Grant College together with Dartmouth College. 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, the Nashua Center, and the Graduate School. The University System of New Hampshire, of which UNH is a member, also includes Keene State College, Plymouth State College, and the College for Lifelong Learning.

The University enrolls more than 12,000 students, has a full-time faculty of about 600, and offers 95 undergraduate and 74 graduate programs. The student body includes more than 1,500 graduate students.

Graduate Education at UNH

Graduate education at UNH is supervised by five hundred graduate faculty members. The Graduate School, in turn, is led by the dean, who implements the policies of the graduate faculty. The dean is advised by the Graduate Council, which is composed of elected faculty members and graduate student representatives.

One of the basic tenets of graduate education at UNH is that for quality graduate education to thrive, research must coexist with, and enhance the process of, classroom teaching. Faculty members of the Graduate School, while dedicated to teaching, carry on active research programs. Their research serves many vital purposes. First, it supports graduate education by developing new knowledge in areas of scholarly interest. Second, it provides training opportunities for graduate students in residence. Moreover, these programs fulfill the University's obligations as a land-grant, Sea Grant, and Space Grant institution by conducting research and disseminating information to the public in areas affecting the nation's welfare.

As the state's only university, UNH occupies a unique role. It is the primary institution within the University System of New Hampshire responsible for providing graduate programs that meet state, regional, and national needs—and the only one at which doctoral programs are offered. Other units of the University System do offer some master's programs.

Master's Programs at UNH

The master's degree programs, which the University offers in a wide variety of disciplines, 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 doctoral programs in those disciplines that have both the faculty and facilities to support high-quality advanced graduate education. 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. After receiving a dual grounding in the development and communication of knowledge, graduates from UNH doctoral programs have gone on to find excellent teaching and research positions.

Interdisciplinary Programs

The Graduate School encourages interdisciplinary study within its existing programs and has adopted procedures for the 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 natural resources Ph.D. program, which draws on the University's strength in environmental and earth sciences, life sciences, social sciences, and policy studies to provide interdisciplinary research opportunities in the broad area of natural and environmental research management; 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; and the resource administration and management program, which involves faculty in the natural resources area.

Opportunities for interdisciplinary study and research are also available through the Institute for the Study of Earth, Oceans, and Space and through the Marine Program. Additional interdisciplinary opportunities are listed with the individual program descriptions.
“My husband and I are both graduate students here. We were looking for schools that had both a good microbiology or immunology department and a good chemistry department. Rob wanted to work with Dr. Mayne, and Dr. Pistole’s work with B-streptococcus and neonatal diseases really intrigued me. My main interest is in pediatric research. It was really important to me to find a professor who matched my interests.

“Our group here works basically on infections of children. I work with Group B Streptococci, which causes meningitis and pneumonia in neonates. Babies don’t have a full immune system, so they’re working with one strike against them. The only thing they have for defense is cells, called macrophages. Macrophages are the professional phagocytes. It’s their job to destroy and kill foreign material. I’m attempting to isolate these cells to see how they respond against the Group B Strep. We already know infants are born with fully functioning macrophages, and by focusing our efforts on them we’re trying to develop, in the long term, a more successful therapy to fight Group B Streptococci.”

Monica Maher
Ph.D. student,
Microbiology
Robert Maher
Ph.D. student, Chemistry
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 for admission. 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 (although, April 1 is recommended), 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 for admission for the fall session only 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 or that have special deadlines 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 materials that are submitted as part of the application receive 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. 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.
**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 changed 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 for two years after the conditional status is removed.

**Deferred Admission**  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 for graduate coursework as special students at the University during the period of deferment.

**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 up to eight graduate credits. (See also dual credit on page 20.)

**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, which normally commence during the fall semester of their senior year. Approved undergraduate programs include the B.S. programs in chemical engineering, civil engineering, electrical engineering, mechanical engineering, or mechanical engineering in the College of Engineering and Physical Sciences; the B.A. programs in French, history, philosophy, or psychology in the College of Liberal Arts; the B.S. program in plant biology in the College of Life Sciences and Agriculture; and the B.A. program in economics in the Whittemore School. Application to the Graduate School is made during the second semester of the junior year. Interested students should contact the Whittemore School for specific information.

**Additional 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 Center, or the College for Lifelong Learning. These individuals are designated as "special students." They 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 20.)

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

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

**Registration**

**Academic Year**

Students admitted to the Graduate School must have their programs approved by their adviser or the chairperson of their guidance committee. Registration information and the Timetable of Classes may be obtained from the Registrar's Office or the Graduate School. 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 a full 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 require a petition form and must be approved by the course faculty member, the student’s adviser, 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 whenever a change is made. Forms are available in the Registrar’s Office and 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 12 credits for the entire summer session. A student will be allowed to exceed this limit only by petition with the recommendation of the student’s adviser, graduate program coordinator, and the approval of the dean of the Graduate School.
"As a graduate student, I teach principles of microeconomics, and it’s been a good experience for me. There’s always a big push in academics to publish. Now’s the time when I can experiment with teaching styles and learn what works and what doesn’t. Successful teaching takes a lot of time, but just giving students multiple choice tests doesn’t help students learn as much as they should. If you want to become a teacher, you have to think about the best way to encourage people to learn.

“My fields are history of thought and philosophy of science. I’m currently doing work in evolutionary theory in economics. Economists have recently been attempting to bring technological change into the economic model—there’s a lot of work coming out in complexity theory being applied to economics, yet there’s this lingering concern that if you’re pulling physics into the social sciences you’re committing some grave error. It began at the turn of the century, when economists tried to incorporate physical theories into the economic model and were accused of having ‘physics envy.’ But I really believe in unified science and think economics has much to gain by incorporating the new technologies into its models.”

Jim Neidhart
Ph.D. student, Economics
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: ½ credit/week or more = full time; ¼ credit/week or more = ¼ time; ¼ credit/week or more = ½ time; less than ¼ 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, and do not extend time limits for completion of courses or degree programs. 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 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  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  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 must complete the appropriate application for a change in degree. These forms are available from the Graduate School. Applications 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 must submit an application for a change in degree. 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.
“I had been working for a government agency, attempting to minimize environmental impacts to wetlands during construction activities. This always involved convincing contractors that the environmental regulations they needed to follow were not only good for the wetlands but could also make them more money. After a while, I decided I wanted to work in wetlands from a more technical perspective, particularly in the area of soils.

“I am currently working on a project in Sweden looking at sulfur gases emitted from peatlands. We know that human-produced sulfur can acidify the environment and influence climate. However, just what role biologically produced sulfur gases play in terms of the total atmospheric sulfur burden is still unknown. In Sweden, we’re using cryotrapping techniques with teflon-coated flux chambers to trap sulfur gases, particularly dimethyl sulfide. This should help us to better understand the importance of peatlands as a source of sulfur to the atmosphere, as well as the significance of these systems to the regional sulfur cycle.”

Jeffrey Simmons
M.S. student, Natural Resources—Soil Sciences
Fees and Financial Aid

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 as well as appeals 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 fifty 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, Thompson Hall, 105 Main Street, Durham, NH 03824-3547, 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, UNH, Thompson Hall, 105 Main Street, Durham, NH 03824-3547.

Tuition and Fees
Tuition and fees are established by a vote of the Board of Trustees. Approval normally occurs between April and July. The current academic year rates are published annually in the Graduate Application booklet. Mandatory 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; a health fee, which funds University Health Services; and a recreation fee, for the use
“I had a sense of belonging from the moment I arrived. The department here is small enough that you can find your niche while making friends with your fellow students and the faculty members. Colloquia also reinforce this sense of community.

“What I find most exciting about the composition program is the great interest in teaching. Although the program is structured by your area of interest, it still allows you the opportunity to interact with faculty in other areas of specialization.”

Lisa Sisco
Ph.D. student, English—Composition

“Because I came to UNH from a women’s college, it was important to me to know that women’s issues and positions, as well as those of other interest groups, were represented and valued within the department. When I saw Melody Graulich’s students’ quilts hanging on the walls of Hamilton Smith, I instantly got a sense of the comfortable, community atmosphere within the department. I knew I had come to the right place.

“Within this environment, I am researching my dissertation topic, which involves rediscovering the works of Dorothy Canfield Fisher. Fisher was a popular novelist of the 1920s and 1930s.”

Anne Downey
Ph.D. student, English—Literature
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. Tuition and fees are payable at registration, and a student is not considered registered until they have been paid. Graduate tuition and fees apply to admitted graduate students enrolling for courses, graduate or undergraduate, 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.

Special Fees

Master’s Continuing Enrollment  Master’s students in residence and registered for Master’s Continuing Enrollment will pay $150 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. Full-time students majoring in business administration or economics will be charged a tuition differential of $150 per semester. Students in these programs who are registered for Doctoral Research 999 or Master’s Continuing Enrollment are considered full time and pay the full tuition differential. Students in engineering or computer science programs (both resident and nonresident) who register for fewer than 9 credits pay a differential tuition of $5 per credit hour. Students in business or economics (both resident and nonresident) who register for fewer than 9 credits pay a differential tuition of $10 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 8 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

Overload  Graduate students are charged full tuition 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 0 credit are billed as if they were for 1 credit.

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

Late Fees  A $25 late registration fee is charged to students who register after the last day scheduled for graduate registration. 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.

Registration Fee  Part-time students (i.e., registering for less than 9 credits) pay a nonrefundable registration fee.

Student Accident and Sickness Insurance  The University encourages all students to be insured against illness or injury that may arise in the course of the academic year. International students are required to have insurance. A student accident and sickness insurance policy is available for all students. Graduate students may enroll in this insurance program on a voluntary basis during graduate registration or through University 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. Students receiving federal financial aid will have their refund calculated in accordance with the U.S. Department of Education regulations in effect at the time of their withdrawal. Specific details regarding the regulations are available in the UNH Financial Aid Office. 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 Aid

There are several forms of financial assistance available to graduate students through the Graduate School and individual departments, 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. The application for admission with supporting documents serves as the application for new graduate students for the scholarship and assistantship pro-
programs available to them and should be completed by February 15 for awards for the following academic year.

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 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. Students are nominated by their major department or program. 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 department or 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 of the academic year. Applications are available at the Graduate School. 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 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 550 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 1993–94 academic-year base stipend levels for assistantships are $8,650 ($8,900 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 $8,950 ($9,200 in biochemistry, chemistry, computer science, engineering, mathematics, and physics).

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 for the period of their appointment and the following summer.

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 for the period of their appointment.

Project Assistants Students supported by externally funded research projects are appointed as project assistants and are involved in the research activities of the project. Project assistants, 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 during the period of their appointment. Project assistants are also eligible to receive waivers to cover the out-of-state portion of their tuition during the period of their appointment.

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 $14,000 per academic year according to the qualifications and duties of the student. A graduate associate may be eligible to receive a tuition waiver during the period of his or her appointment.

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 1/2 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.

Other Forms of Aid
Limited amounts of aid from federal and state sources are available through the Financial Aid Office. This office distributes money from various sources to help students with financial need. Need is defined as the difference between what it costs to attend UNH and what the student and his/her family can contribute from their financial resources, including all other sources of assistance. The student is expected to earn a portion of these resources. The Free Application for Federal Student Aid (FAFSA) should be submitted to the federal processor listed on the envelope as soon after January 1 as possible but prior to February 15 for priority consideration for fall semester. The FAFSA is required for all of the programs listed below with the exception of the Veterans' Benefits. For further information or copies of the forms, contact the Graduate Financial Aid Coordinator, Financial Aid Office in Stone Hall (603-862-3600).

Federal Perkins Loans Graduate students may borrow up to $30,000, including any undergraduate loans. These loans have a simple interest rate of 5 percent annually. Minimum payments of $40 per month are required, and the repayment period may extend up to ten years. Repayment and interest do not begin until six months after the student ends at least half-time study. To be eligible for consideration, students must carry at least 5 academic credits per semester, be citizens or permanent residents of the U.S., and establish need for a loan which is to be used for educational purposes only.

Federal 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. Students interested in summer work-study should apply (and send their FAFSA to the federal processor and submit separate application for the Summer Federal Work-Study Program to the Financial Aid Office in Stowe Hall) as soon after January 1 as possible, but prior to February 15.

UNH Loans Students who are registered degree candidates are eligible for consideration for a UNH loan. Financial need must be demonstrated clearly, and loans may be used only for educational expenses. No interest is charged until separation from the University occurs. Interest is 3 percent on any unpaid balance and repayment begins nine months after separation from the University. The maximum amount granted to a student is $1,000 during his or her undergraduate and/or graduate work.

Federal Stafford Loan Program A federal Stafford loan is a low-interest loan made to a student-borrower by a bank, credit union, or savings and loan association and is based on financial need. The interest rate varies between 7 and 9 percent. Graduate students may borrow up to $8,500 per academic year. The total maximum debt for graduate study is $65,000 including Stafford loans made at the undergraduate level.

Borrowers may have the interest on their loans paid by the federal government while attending college. Repayment begins six to nine months after students cease at least half-time attendance.

Unsubsidized Federal Stafford Loan Program Unsubsidized federal Stafford loans are non–need-based Stafford loans for students who do not qualify in whole or part for the subsidized federal Stafford loan. The student borrower, not the federal government, is responsible for paying the interest that accrues while he/she is in school, and during grace and deferment periods. To apply for an unsubsidized Stafford loan, you must first submit a Free Application for Federal Student Aid (FAFSA) form even though this loan is not based on financial need. Graduate students may borrow up to $8,500 per academic year. The total maximum debt for graduate study is $65,000 including Stafford loans at the undergraduate level.

Supplemental Loans for Students (SLS) SLS loans are available to provide additional funds for educational expenses to independent graduate students. Under this program, qualified students may borrow up to $10,000 per year to an aggregate total of $73,000. Borrowers do not have to demonstrate need, but in no case may the SLS loan exceed the student’s cost less estimated financial assistance. The interest rate on SLS loans is variable but will never exceed 11 percent.

Veterans' Benefits Veterans and their dependents should investigate their eligibility for veterans' benefit payments. Questions may be addressed to any local Veterans Administration office or the UNH Veterans' Coordinator, Registrar's Office (603-862-1595).

Satisfactory Academic Progress 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.
I'm a critical care nurse with sixteen years of experience. When it came time for me to consider graduate school to achieve my goal of becoming a clinical nurse specialist, I looked at a number of different master's programs. I spoke with my friends and their advice was: go somewhere where they use a humanistic model and where you'll build critical thinking skills. I found pretty quickly that I really loved being back in school and that I loved the program at UNH.

“I'm an adult; I've been out of school for sixteen years, and the program here acknowledges that. At the same time, I'm learning things from a different perspective. My specialty involves the postoperative care of cardiothoracic patients. My interest is in the role hypothermia plays in the recovery of these patients. For years we've used fluid-circulating warming blankets to treat patients with hypothermia. We've seen clinically that they are not effective yet little has been done to validate that observation. That's my goal and will be the driving force behind my thesis work. My postgraduate goal is to become a clinical nurse specialist, which involves teaching and research as well as bedside care. Unless you know what pressures nurses face when they work at the bedside, you can't help them prepare for it.”

Mary Sanford
M.S. student, Nursing—Clinical Specialty
Academic Regulations and Degree Requirements

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. The general requirements of the Graduate School are found in the catalog. Individual program requirements may be found in the catalog or obtained from the respective department.

Graduate Courses

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 program other than the one in which the student is earning the degree. Such courses must be taken for a letter grade. Petition forms are available at the Graduate School.

Graduate Grading

Every instructor must be prepared to discuss and explain the basis for her or his evaluation of students. If, after consulting the instructor, a student still believes that she or he was treated unfairly, she or he has the right to seek redress from the chairperson of the department or program in which the course is offered. Under exceptional circumstances, a final appeal may be made to the dean of the college or school in which the program is offered.

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 to either 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 enrolled in the Graduate School are counted in the cumulative total of failing credits. Repeating a course does not remove the original failing grade from the record.

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 8) may, upon recommendation of the department and approval of the Graduate School, be allowed a maximum of two graduate-level courses for up to 8 credits, 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 a maximum of two courses, for up to 8 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.

Special Student Credits

Special-Credit Rule  A maximum of three courses for up to 12 credits completed by a special student in University of New Hampshire graduate courses 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 Off-Campus 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 Off-Campus Rule  Students who are admitted to external graduate degree programs are exempt from the 12-credit off-campus rule. The programs that are currently approved as external degree programs include the M.S. program in computer science, electrical engineering, and mechanical engineering at the Nashua Center and the M.Ed. program in educational administration and supervision at UNH-Manchester.

Students who are admitted to all other graduate degree programs are subject to the 12-credit off-campus 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
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 graduation 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 within this range 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 by the appropriate deadline as published in the Graduate School calendar. 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 Proficiency Each doctoral program has its own language and/or research proficiency 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 upon recommendation of the graduate program coordinator 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 program, the dean of the Graduate School 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 Three copies of the approved dissertation, ready for binding, shall be submitted to the Graduate School Office by the appropriate deadline in the Graduate School calendar. 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 Graduate School at the beginning of the semester in which they intend to graduate. Specific information is available at the Graduate School.

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. While graduation occurs three times a year, the annual commencement ceremony is held in May.
Research

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 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.

Agricultural Experiment Station

The Agricultural Experiment Station (AES), one of the largest research and service units at the University, is supported by the 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 molecular biology to biotechnology. Scientists and graduate students from eight departments in the College of Life Sciences and Agriculture are involved in research through the AES.

Institute for the Study of Earth, Oceans, and Space

The Institute for the Study of Earth, Oceans, and Space (EOS) 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 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 geochronal systems, and the natural resources degree. 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, natural resources, 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 50 for a description of these courses, and pages 51, 90, and 99 for the admission and degree requirements for the graduate programs in earth sciences, natural resources, and physics.

Biogeochemical Systems Center

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.

Complex Systems Research Center (CSRC)

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 examining 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.

Glacier Research Group

The Glacier Research Group is 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
"What I’ve done in the past is called magnetospheric physics. The Earth has a north and south pole with magnetic field lines extending out from the poles beyond the atmosphere and ionosphere, forming sort of an apple shape. Then you’ve got the solar wind, pushing against the earth’s magnetic field like water against a rock in the river, and it causes the magnetosphere—which is this magnetic field environment—to blow back into a tail on the opposite side of the earth.

“In the project I came here for, we launched a satellite to look specifically at the Van Allen radiation belts. When you send up a satellite, electrons and protons hanging around in the magnetosphere jump into your computer chips and mess them up. To protect instruments (or astronauts), you can put a lot of shielding on the satellite (or the shuttle). The catch is: the more shielding on the satellite, the heavier it is, and the more expensive to launch. You want to hit the optimum balance between how much shielding you need and the weight of the spacecraft. The radiation affects whatever you put out there.”

Carolyn Jordan Ph.D. student, Physics
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).

**Ocean Process Analysis Laboratory (OPAL)**

OPAL focuses on physical ocean science research. The three principal researchers and thirteen other professional technical staff and students are involved in a number of ocean-going research programs in such places as California, the Strait of Gibraltar, and the local Gulf of Maine. Other efforts include climate-related studies of the North Brazil Current in the equatorial Atlantic and the development of satellite data telemetry schemes for global ocean observation.

**Space Science Center**

This research unit 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.

---

**Marine Program**

The UNH marine program supports research, education, and service projects involving the estuarine and marine environments. It is closely tied to graduate 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. The marine program includes the Center for Marine Biology, the Ocean Engineering Center, the Center for Ocean Sciences, the University Diving Program, University research vessels, and UNH participation in the UNH/University of Maine Sea Grant College Program.

**Center for Marine Biology**

The Center for Marine Biology serves faculty based in five academic departments of the College of Life Sciences and Agriculture and maintains the UNH participation in the Shoals Marine Laboratory, a joint education program with Cornell University.

The primary goals of the Center for Marine Biology are to foster marine biological research and graduate education, especially multidisciplinary projects among life scientists or between life scientists and other marine researchers at UNH, and to maintain a set of research laboratories available to University faculty or graduate students with interests in any appropriate area of marine research.

Researchers associated with the Center for Marine Biology study diverse marine-related topics that are of importance to the state or region, or of national or international scope and significance. All faculty members are also affiliated with academic departments, through which marine-related graduate and undergraduate degree programs are available. Research by center members is currently supported by the National Science Foundation, by several NOAA agencies (including Sea Grant), and by various state agencies, as well as by private foundations and limited University funds. Current research topics include a focus on molecular mechanisms of genetic expression, growth and development in various marine animals, a strong emphasis on interdisciplinary studies of the Great Bay estuarine system, and studies on the recruitment biology of important fish and marine invertebrates.

The **Jackson Estuarine Laboratory** is located on Great Bay about five miles from campus and fourteen miles from the ocean via the Piscataqua River. The lab supports research in estuarine science including ecology, sedimentary geology, marine microbiology, and aquaculture of estuarine species. The Jackson Lab has four resident faculty members and also provides a site for the Center.

The **Coastal Marine Laboratory**, a running seawater facility, is located about 15 miles from campus at Fort Constitution, New Castle. It serves as a location for research involving living marine organisms or other studies requiring a reliable supply of clean ocean water.

The **Anadromous Fish and Aquatic Invertebrate Research Laboratory**, located on campus, is a running freshwater facility designed for the maintenance and rearing of anadromous fishes and freshwater invertebrates. It supports the research of several faculty members on freshwater species.
Center for Ocean Sciences

The Center for Ocean Sciences (COS) is composed of faculty from a variety of disciplines whose research addresses critical questions concerning the coupled atmosphere/ocean/land system. Physical, chemical, and biological oceanographers join with ocean and atmospheric geochemists in research efforts that seek to unravel the complex processes that are important on estuary, coastal ocean, and global Earth scales. COS researchers currently address questions related to: how circulation affects the distribution of nutrients and zooplankton in the coastal and open ocean; how ocean vent systems and the geochemical processes in marshes affect the chemistry of estuarine waters and the atmosphere; how variability in the tropical Atlantic is related to climate change in the Atlantic basin; and how the ocean is involved in the global carbon cycle. The COS academic research programs emphasize both the direct and remote observation of the oceans and atmosphere as well as the integration of those observations with modeling efforts.

Ocean Engineering Center (OEC)

The OEC is responsible for the integration of the academic and research activities in ocean engineering. The OEC is the focal point for coordinating the research activities in the Ocean Process Analysis Laboratory (OPAL) and the research activities of the faculty. This organization enables the graduate student in ocean engineering to pursue an interdisciplinary program of study. To achieve the academic and research agenda, OEC participants have access to the center’s facilities and the resources of OPAL as needed. Access to the University’s Diving Program and research vessels is an essential part of the OEC.

The research agenda of the OEC is concerned with the effective and wise utilization of the coastal ocean, which extends from the estuary out to the limits of the Exclusive Economic Zone, for resource development, assessment, and management. This requires an agenda that includes research or modeling, measurement and data calculation, and information processing. This is manifested in the following six research areas. Ocean instrumentation is focused on the development of sensors and sensor systems and is vital to the study of oceanic processes. Underwater vehicles are used to investigate intelligent system technology. Successful investigations at UNH are already making or having significant impacts in the offshore oil and gas industry, ocean science, and national defense. Marine pollution is one of the most visible social issues concerning the coastal ocean. Beach closures, waste dumping, floatables, and dredged material disposal are important local and national issues. Coastal and estuarine hydrodynamic modeling is important in oil spill response, sediment transport, and port and coastal zone management. Geotechnical and geoacoustical characterization of the seabed is critical to foundation design and stability, and remote acoustical site surveying. Ocean information systems concerns the development of methodology to extract critical information from vast data sets developed from satellites, fixed platforms, or underwater vehicles which is necessary to understand oceanic processes.

Sea Grant College Program

The University of New Hampshire and the University of Maine form a joint Sea Grant College Program that provides support, leadership, and expertise for marine research, education, and advisory service in northern New England. As part of the National Sea Grant College Program, the UNH-UMaine Sea Grant College Program is one of a network of twenty-nine in the nation. All of the programs are dedicated to promoting the understanding, development, wise use, and conservation of ocean and coastal resources through university-based research, education, and advisory services. There is opportunity for graduate students to get involved in nearly all projects supported by sea grant.

The UNH/UMaine Sea Grant College Program works with marine industries, government agencies, private organizations, and individuals to identify and solve problems associated with the conservation and development of the region’s marine resources. Through its information, education, and public service efforts, the program increases awareness of marine and coastal issues and promotes responsible use of these resources.

University Diving Program

The Diving Program offers introductory and advanced instruction in SCUBA diving, supervises safety of diving operations by students and staff of UNH, and maintains a hyperbaric chamber for research use and non-emergency medical use. This program provides the essential logistic support to all diving activities by University personnel.

Research Vessels

The R/V Jere A. Chase is a 45-foot research vessel equipped for a wide variety of marine research activities in the estuary and near-coast waters. In addition, there are several outboard skiffs available for research purposes which are berthed at the Jackson Estuarine Lab and the Coastal Marine Lab. A new, 50-foot, state-of-the-art research vessel—as yet unnamed—will be on line in the summer of 1993.

Center for Business and Economics Research

The Center for Business and Economics Research provides applied research and information facilities for business and tracks economic indicators. It develops multisectational, multi-regional econometric models for long-term planning and development. It impacts studies of events and proposed policies in order to support decision making. It supplies analyses of international business conditions, foreign investment, and export promotion strategies.

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 dissemina-
tion of educational and research materials; it fosters and develops relevant outreach activities in the humanities for the state and region; and it acts as 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, service, and education. 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.

Environmental Research Group
The Environmental Research Group (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 physicochemical treatment processes, solid and hazardous waste management, environmental chemistry 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 Family Research Laboratory also conducts studies on many other aspects of the family, including communication patterns, the balance of power in marriage, and methods of measuring key aspects of the family. Laboratory work is supported by grants from the National Science Foundation, National Center on Child Abuse and Neglect, National Institute of Justice, and the National Institute of Mental Health. Graduate students are actively involved in the research activities of the laboratory.

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.

The institute's Social Survey Center conducts public opinion studies for a wide variety of clients. 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 secure external research funds, aids in the dissemination of results, and offers research facilities to house interdepartmental groups.

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, and 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. The institute receives several federal grants in early intervention, supported employment, and education.

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 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 and teachers to conduct research in reading and writing instruction and to study the research of others. The laboratory, staffed by internationally known faculty, is currently conducting research on the relationship between reading, writing, and evaluation. The United States Department of Education, the Ford Foundation, the New Hampshire Department of Special Education, and other foundations have all supported the laboratory's pioneering work.
"The Holy Grail for me in psychology is the relationship between mathematics and the living world: How can numbers be meaningfully applied to actions and decisions that living organisms make? To answer this question you need high-quality data, so we run experiments with pigeons in computer-controlled chambers. How does this relate to human behavior? Pigeons have something in common with people: they’re impulsive. You might even say pigeons are compulsive gamblers. It’s easy to arrange a situation where pigeons, through trying to maximize short-term gain, lose out in the long run. Pigeons, like people, are often irrational in their decision making. The reason is that pigeons’ sense of time, like ours, is nonlinear: An event that occurs immediately is much more highly valued than the same event occurring after even a short delay. My research in particular examines whether pigeons’ choices are transitive; in other words, whether their choices are logically consistent. Naturally, they’re not. I’ve developed a quantitative model that can predict transitivity violations and am collecting data to test it. I hope eventually to extend the model to human choice behavior. Research in this area—quantitative analysis of behavior—may help us to understand the origins of human irrationality (i.e., what causes war, environmental destruction) and other important quandaries.”

Randy Grace
Ph.D. student, Psychology
Graduate Life

The Campus

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 in both the architecture and small-town atmosphere. Graduate students have found Durham to be an ideal place to live while completing a graduate degree at UNH. For those interested in cultural pursuits, Boston is a quick 65 miles to the south. Outdoor enthusiasts will find skiing, hiking, and the scenery of the White Mountains 60 miles to the north and the sandy beaches and rocky coast of New Hampshire and Maine 10 miles east.

The University is sited on a 200-acre campus, surrounded by rolling fields, farms, and woodlands owned by the University. A 15-acre wooded tract, known as the Ravine, graces the center of the campus and provides members of the University community some natural quiet amid the 74 classroom, research, and service buildings and 36 residential buildings of the campus.

UNH Library

With more than one million volumes, 6,500 periodical subscriptions, a million government documents, patents, maps, sound recordings, compact disks, videocassettes, manuscripts, and other related material, the UNH library has a wealth of resources for teaching, research, and personal needs. The library has several computerized periodical indexes available for free searching. Users can find citations for magazines, journal and newspaper articles, dissertations, and papers and conference proceedings on compact disks, and can print out those citations, article summaries, and sometimes even the entire article. The library’s card catalog is computerized and its online public access catalog, or OPAC, searches for materials by the same methods used for searching the card catalog but adds many other features as well. The OPAC displays not only the holdings of the University library and Durham Public Library but also those of several area libraries.

Government documents receive over 90 percent of U.S. Government publications including congressional hearings, federal regulations, departmental publications, maps, and patents. The Listening Room has a variety of musical and spoken recordings in all formats for classroom and individual needs. Special Collections contains unique collections of rare books, historical documents, and manuscripts.

The branch libraries, specializing in scientific materials, contain CD-ROM periodical indexes as well as print indexes and journals related to the physical and biological sciences. The branch librarians provide (upon request) bibliographic instruction and assistance in these specialties.

Staff members in the reference, branch, documents, and special collections areas provide any needed assistance in locating materials. The reference and branch librarians can provide computerized online searches of all major databases available through Dialog, STN, and BRS. Tailored SDI services are available to keep graduate students up to date on their research fields. Interlibrary loan can obtain materials that the library doesn’t own. The library can lend or borrow from libraries worldwide.

The library has a graduate study area with assignable locked book trucks. Check with the main desk for availability. The UNH library is also the Durham Public Library. Spouses and children of graduate students may borrow books from the library. They will need to register at the main desk.

In addition to books and magazines, the Children’s Room provides story hours, summer reading programs, crafts, films, and other special activities for preschool-aged and older children.

Computing and Information Services

All graduate students at UNH have access to mainframe computers and to microcomputers. Students use programs that have been designed by professors for their classes; they write papers, search library bibliographies, develop statistical analyses, and design roads and bridges using computers.

Microcomputing

UNH has four microcomputer centers for use by students. These centers are conveniently located in classroom buildings and the student union. They are equipped with 150 IBM PS/2 and Apple Macintosh personal computers and compatible printers. Each center has a library of software for word processing, spreadsheets, graphics, modeling, and statistical analysis. Some students use their own software or software provided by their instructors. The centers are staffed by student consultants who help users with questions or problems.

Mainframe Computing

The University has two large computers available for academic use by students and faculty members: a VAX 8820 running the VMS operating system, and a DEC 5500 running the RISC-ULTRIX operating system. These computers operate 363 days a year, 24 hours a day.

Any student may arrange for an account on the VAX computer, and students may use these machines via terminals in any of three large systems computing centers (or with terminal emulation programs in the small systems centers). The large systems centers are staffed by student consultants during peak hours and have workstations adapted for wheelchair access.

There are approximately 75 remote terminals and graphics devices located in classroom buildings on campus. Students regularly use these machines to learn symbolic algebra (mathematics), to analyze data (sociology), and to run process flowsheet simulations (chemical engineering). Students may also use electronic mail and Internet, a national and international academic computer network, for correspondence and file transfer. Four new DECstation 2100 workstations are available for student use in the McConnell Hall computing center. These RISC-ULTRIX—based machines are used primarily by students in computer science.

Computing and Information Services supports a library of general-purpose software, including statistical packages and graphics; and discipline-specific software in fields such as engineering, biochemistry, forestry, sociology, and computer science.

The University is an affiliate of three National Science Foundation supercomputing sites: the National Center of Supercomputing Applications (Urbana, Illinois), the Cornell National Supercomputing Facility (Ithaca, New York), and the University of Pittsburgh Supercomputing Center (Pittsburgh, Pennsylvania). These agreements permit UNH faculty, researchers, and students to use the most powerful computer technology in academic and research activities at UNH.
Research Computing

The Research Computing Center (RCC) houses four Prime systems: a 6650 and three 4150s, running the PRIMOS operating system and UNIX systems made by various vendors. There is also a VAX system 3800. All systems are interconnected using Ethernet and PRIMENET local area networks.

Graduate students in electrical engineering and computer science have an opportunity to work with faculty researchers in the RCC in computer communications fields and related areas including artificial intelligence, networking, and fiber optics. Some students involved in research projects use workstations in the CADLAB (computer aided design laboratory) to access Prime's MEDUSA software, and the AutoCAD—programs that generate high-quality mechanical drawings. The Digital-sponsored Visualization Center is also housed in the CADLAB, enabling students to work with graphic information systems using ULTRIX-based workstations.

Computer Purchases

Full-time students who want to purchase their own computers can do so at the University Technology Center, a computer store located on the ground floor of Thompson Hall. The Technology Center carries IBM, Apple, Dell, and Hewlett-Packard equipment, some popular software packages, and a wide range of computer supplies at significant discounts. The staff helps students decide what system meets their needs.

Teaching and Learning

Students can learn about computing through free short courses offered every semester, many of which include hands-on training. Some courses may be viewed on videotape. The Training Center also offers computer-based training, which combines an instructional videotape with software for hands-on exercises. Additional support and training are available through course handouts, documentation and guides, VAX online HELP, and on-disk tutorials. Computer and Information Services publishes a quarterly newsletter called On-Line and a monthly bulletin called Keyed In with current information about computing on campus.

Campus-Wide Information System

The UNH campus-wide information system is accessible from any terminal on campus; there are also dedicated terminals located conveniently around campus (in the MUB, library, Field House, Elliott Alumni Center, Thompson Hall, and elsewhere). The system offers users quick and easy access to information about the University—daily events, clubs, activities, University policies, and important phone numbers. It is updated daily.

Organizations

Graduate students are an integral part of the University community. Yet they have needs and interests that differ from other University groups. Thus, the Graduate School, the University, and the Graduate Student Organization have worked in concert to provide graduate students with access to facilities and organizations that meet their diverse needs and interests.

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 Thompson Hall.

Graduate Council

The Graduate Council, composed of ten graduate faculty members and three graduate students, advises the dean of the Graduate School on policies concerning graduate education and is responsible to the graduate faculty for recommendations concerning new graduate programs. Standing committees of the council include the doctoral program committee, the master's program committee, and the student affairs committee.

Graduate Student Organization

Graduate students play an active role in the life of the University community. The Graduate Student Organization (GSO) represents the interests of the graduate student body by providing a framework for graduate student participation in University governance. The GSO's goal is to foster the continual improvement of graduate student life at UNH. The GSO's purposes are: to provide a representative structure for the graduate student body; to serve as an advocate for graduate student concerns and to be a resource for graduate students; to establish and maintain an effective means of communication between graduate students, faculty, and administrators; to participate in the decision-making process for establishing University policies and/or setting priorities which affect graduate student life; to initiate and administer programs and services for the graduate student body and the University as appropriate; to monitor the development of all mandatory fees and the services which they support; and to provide the graduate student body regular, open meetings for participation in graduate student governance.

The board of the GSO has representation from each department with an approved graduate program and provides representatives to most of the major University committees.

Facilities and Services

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 TV and social 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 elected representatives. 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, Pettee House, University of New Hampshire, 14 Garrison Avenue, Durham, NH 03824-3558.

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 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. A brochure and application can be requested by writing to Forest Park Manager, 160 Forest Park, University of New Hampshire, Durham, NH 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 (Pettee House, University of New Hampshire, 14 Garrison Avenue, Durham, NH 03824-3558) or complete and return the Summer Housing Application Form in the Summer Session Bulletin.

Off-Campus Housing The Office of Student Activities operates the Commuter/Transfer Center, which assists students in obtaining off-campus housing and provides services and support to UNH’s commuter population. Students are encouraged to visit or contact the Commuter/Transfer Center in the Memorial Union Building (603-862-2136) or to access the housing list on the campuswide information system.

Dining Facilities All graduate students are eligible to purchase contracts for dining hall meals. Babcock House has limited communal cooking facilities, none in individual rooms. Students may choose a 19 or 13 meals-per-week plan, a 5-lunch/week plan, any 7 meals-per-week plan, or an “any 35 meals” plan. Any of the above may be owned separately or in conjunction with a declining balance account known as Cat’s Cache, which may be used to purchase meals and snacks at the MUB Cafeteria. All dining plans are administered electronically through a magnetic strip in the student’s University ID card.

For a descriptive brochure about available dining services and a purchase contract, please contact UNH Dining, 20 Stillings Hall, 20 Ballard Street, Durham, NH 03824-3555 (603-862-1821).

Recreational Facilities
The Department of Recreational Sports offers a comprehensive selection of activities including intramurals, club sports, noncredit fitness classes, and informal recreation. Graduate students are encouraged to put to full use the facilities, equipment, and imagination of the recreational sports staff. They can gain access to all activities by using their student ID and will receive reduced rates for noncredit fitness classes.

Informal Recreation The informal recreation program offers graduate students the opportunity to participate in self-directed recreational activities—a chance to relax, get some exercise, or do whatever they like to get away from it all. Activities include basketball, volleyball, swimming, skating, racquetball, squash, tennis, jogging, weight lifting, and using the new Fitness Center. Schedules for open recreation use of the Field House, New Hampshire Hall, and Snively Arena are published at the beginning of each month and are available at the Field House or at the University Information Center in the Memorial Union Building.

Intramurals The intramural program consists of competitive individual and team sports. The program includes men’s and women’s intramural sports, co-rec intramural sports, and special events. To learn more about the program, contact the Babcock House sports managers (for on-campus students), the Commuter/Transfer Center, or the recreational sports staff in the Field House.

Club Sports Club sports provide an opportunity to stay in shape and develop athletic skills for competition and demonstrations. Some clubs are intensely competitive and require daily commitments to workouts and conditioning. Others meet on a casual, come-when-you-can basis.

Noncredit Fitness Programs The recreational sports department offers a variety of individual and group activities designed to make it easy for students to reach their personal fitness goals. These programs will teach new skills and build upon those one already has.

Employment The recreational sports department hires approximately 250 students to officiate intramurals, teach fitness classes, and to assist with the supervision of facilities for open recreation. For more information, call 862-2031.

Memorial Union The Memorial Union, a gift of UNH alumni and the only New Hampshire state war memorial, is the University’s community center. The MUB has been the site of many major events (i.e., presidential candidate visits and debates; including guest lecturers Jesse Jackson, Spike Lee, Ralph Nader, Billy Baldwin, and Sarah Jessica Parker). It houses the Information Center, a convenience store, coffee shop and card shop, the
The MUB offers meeting and study space, food, entertainment, the opportunity for student employment and involvement, and much more from early morning to late night in a casual atmosphere.

University Health Services
The University Health Services provides comprehensive primary health care, including laboratory examinations, x-rays, limited physical therapy, pharmacy services, and limited mental health care. The staff maintains close relationships with other specialists in the area to whom they may refer patients for surgical or subspecialist care. Three well-staffed and -equipped community hospitals are located nearby, and an emergency ambulance service is available in Durham at all times.

During the regular academic year, University Health Services is staffed by seven full-time physicians (three specialists in adolescent medicine, two internists, one gynecologist, and one family practitioner), physician assistants, nurses, and part-time consultants. Appointments with physicians and physician assistants may be made upon request. An appointment is not necessary for medical problems requiring immediate attention; such cases are treated through the outpatient clinic on a walk-in basis.

Office of Health Education and Promotion This office provides confidential counseling and referrals, and offers health workshops. Its resource room contains information on a variety of physical and emotional health issues, including HIV/AIDS, alcohol, smoking, women’s and men’s health, birth control, heart disease, sexuality, eating concerns, and stress management. These services and programs reflect the University’s commitment to promoting awareness of such problems, encouraging responsible behavior and informed decision making, and helping students develop self-esteem. Students may drop in and arrange for an appointment or call the office at 862-3823.

Health Fees A mandatory health fee is assessed to all students. Payment of the fee entitles the student to unlimited visits to Health Services physicians, physician assistants, and clinic nurses; when ordered by a Health Services practitioner, unlimited routine x-rays and laboratory procedures performed at Health Services; the first $50 of off-campus laboratory work when it is ordered and the specimen is collected by a Health Services staff member for transmittal to the Health Services laboratory contractor; health education visits; medicines for treatment of acute illnesses and injuries if the medicine is stocked in the Health Services pharmacy; family planning services; and one physical examination except for routine exams without specific purposes.

Services not included under the health fee are medicines for treatment of chronic illness; consultative visits at the health center; x-rays performed outside of the Health Services Center; off-campus laboratory tests performed in any other laboratory (e.g., Wentworth-Douglass Hospital and Leary Lab); contraceptive devices or medicines; orthopedic appliances or casts; and emergency room visits ordered by the Health Services staff. A student accident and sickness insurance policy is available through Health Services. It covers most health care needs not covered by the health fee, including major medical payments. It is specifically designed to work in conjunction with the student health fee and may supplement or replace other insurance. Pre-existing conditions may not be covered. A student health insurance brochure providing details is available from Health Services.

Health Record Requirement In order to provide effective health service, the University requires that students who have been formally accepted to a graduate degree program must have complete medical records on file with University Health Services. These records consist of (1) a health history to be completed by students on a form provided by the University Health Services and (2) proof of immunity to measles. Students must have had two live-virus measles vaccinations after twelve months of age. Students wishing exemption from this requirement on religious grounds must make a written request to the medical director of University Health Services. It is the responsibility of students to complete the forms before the beginning of classes. Any student failing to complete these requirements will not be allowed to register for classes.

Summer Session During the summer session, University Health Services provides limited services and is open Monday through Friday from 8 A.M. to 4 P.M. Students enrolled in summer courses are required to pay a summer health fee. Graduate students who are not enrolled in classes and are engaged in legitimate academic work in the summer may pay the summer health fee. Graduate students who are enrolled in the student health insurance program may use Health Services during the summer; as required by the student health insurance policy, without paying the summer health fee. However, graduate students enrolled in the student health insurance program who do not pay the summer health fee will be billed on a fee-for-service basis for services received during the summer.

Counseling Center
The Counseling Center offers confidential professional consultation, individual and group therapy, and educational workshops for a broad range of emotional, mental, and interpersonal concerns. The center offers services without charge to students who may be facing a major crisis, confusion, depression, family difficulties, or other personal problems. In addition, the center provides psychological testing. For information, call 862-2090.

The center provides a scheduled intake system. In addition, the senior staff provides psychological emergency consultation to Health Services twenty-four hours a day, seven days a week during the regular academic year. When necessary, the center’s staff assists with outside mental health referrals.

The staff, which includes certified licensed psychologists and counselors, is committed to the welfare and development of UNH students. The staff is available for consultation with faculty, administrative staff, and parents on matters relating to the welfare of students.

All information about a student’s visits to the Counseling Center is confidential and cannot be released without the permission of the student.
Career Services
The Office of Career Services assists students at every stage in their career development from help with career goal clarification to job placement. Interest tests, career counseling, placement workshops, a parent/alumni career advisers network, internships, part-time jobs, and an on-campus interviewing program are all available. A library of information on employers and career information is also available to help with the student's career goals. A credential service that sends letters of recommendation, transcripts, and so on, to prospective employers in education and not-for-profit organizations may be useful to students. The campus-wide information system carries complete information on Career Services offerings and campus recruiting information.

Office of Multicultural Student Affairs
The Office of Multicultural Student Affairs works toward understanding and acceptance across race, ethnicity, religion, and sexual orientation. The goal is full participation in all academic, social, and recreational groups and activities by members of each of the University's populations. Seminars, workshops, and leadership training opportunities are available. The office focuses on the value of multiculturalism to the campus community; promotes diversity, integration, and interaction through both structured programs and informal opportunities for dialogue; and contributes to the campus-wide multicultural programming efforts.

International Student Office
The International Student Office (ISO) provides counseling, programming, and administrative support to international students and serves as a general resource and referral center. The ISO is responsible for the reception and orientation of new international students and providing assistance with immigration matters. All international students are encouraged to maintain contact with the ISO and are required by law to report changes of address, academic program, or source of educational funds.

Other Services
ACCESS Students with a physical or mental disability that limits one or more major life activities, such as walking, seeing, hearing, speaking, working, manual tasks, or learning, are encouraged to inform the ACCESS Office (Accessing Career Challenges in Education through Specialized Services), Room 200, Memorial Union Building (603-862-2607 VOICE/ TDD), of the enabling accommodations they require.

The University encourages disabled members of its community to use existing services and to become involved in the mainstream of campus life. Inquire through the ACCESS Office for information about priority scheduling, accessible classrooms, special parking arrangements, assistance in securing academic aides, accessible on-campus transportation, reading services, interpreters, and other special arrangements.

Commuter/Transfer Center
The Commuter/Transfer Center, located in the Memorial Union, helps commuter students with off-campus living. The staff will answer questions about renting, area landlords, consumer issues, and commuter-related problems. Lists of available rental houses, apartments, rooms, and names of people looking for roommates are published weekly and on the campus-wide information system.

Other services include emergency housing, roommate file box, the housing/work exchange program, a ride board, babysitting pool for student parents, and intramural signups and information. Typewriters, calculators, jumper cables, and dictionaries are available for student use.

Child Care Resource and Referral Service
Information about Seacoast area child care and assistance in finding appropriate care are available through the UNH Child Care Resource and Referral Service (603-862-2895). The University also operates on-campus daycare and preschool programs. Call 862-2835 for further information.

The Sexual Harassment and Rape Prevention Program (SHARPP)
This program offers intervention and prevention services around the issue of sexual violence. Three staff members and sixty-nine volunteer victim advocates provide crisis intervention services to survivors and their significant others on a twenty-four-hour basis. Advocates provide survivors with support and options surrounding legal, medical, administrative, and therapeutic issues. Support groups and one-to-one support is available to male and female survivors, as well as their significant others. Additional advocates provide peer education to the UNH community. Educational programs are conducted in fraternities, sororities, athletic teams, residence halls, student organizations, and academic classes. For more information, call 603-862-3494 Monday through Friday, 8:00 A.M. to 4:30 P.M., and 603-862-1212 twenty-four hours a day.

Women's Commission
The Women's Commission consults with other University offices and organizations, faculty, staff, and students to help promote the status of women and to encourage the full participation of women throughout the University. It provides education and programs aimed at helping women develop new skills and continue their education, increasing networking among women, and informing the University community of issues relating to the status of women. The commission collects information on current UNH salary, hiring, enrollment, and retention of women. All women graduate students are encouraged to become part of the commission. The commission is located in Batcheller House on Rosemary Lane. The office is open 8 to 4:30, Monday through Friday (603-862-1058).

Veterans' Information
The UNH veterans' coordinator, located in the Registrar's Office (603-862-1595), provides counseling on all aspects of veterans' benefits as well as assistance in procuring and completing the required forms and certifications for veterans' benefits. The veterans' coordinator maintains a comprehensive directory to assist veterans in contacting state, local, and University resources for housing, daycare, career planning, employment, financial aid, tutorial assistance, remedial training, handicapped services, and Vietnam Veterans' Outreach. The coordinator also provides a framework for networking among campus veterans.
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.

All courses flagged with a # have not been offered in the last three years.
cellular and molecular mechanisms. Includes the nervous, muscular, cardiovascular, renal, gastrointestinal, and endocrine systems. Prereq: human anatomy and physiology, principles of animal physiology, and one semester of biochem. or permission. 4 cr.

820. Public Health 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. 4 cr. (Offered alternate years.) (Also offered as GEN 822.)

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. Nutritional Biochemistry
Study of the digestion, absorption, transport, and utilization of food nutrients from a biochemical perspective. Emphasis on the role of macro- and micronutrients as substrates and catalysts for metabolic pathways, and the role of these pathways in maintaining human health at the cellular, organ, and whole body levels. Prereq: general biochemistry. 4 cr.

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 bulimia 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 physiological 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.)

900. Topics in Animal and Nutritional Sciences
An informal forum for graduate students to gain experience in organizing and presenting a research seminar. Each student presents one or two seminars during the semester on a research paper(s) of their own choice, and the instructor provides feedback. Prereq: ANSC graduate students only. (May be repeated to 2 cr.) 1 cr. Cr/F.

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. Amino Acid Metabolism
Intermediary metabolism and interorgan transport of amino acids and nitrogenous compounds in the mammalian system. Prereq: ANSC 905. 2 cr. (Offered first half of the semester.)

905. Intermediary Metabolism and Exercise
A. Regulation of mammalian cellular metabolism by enzymes, effectors, hormones, and diet in response to exercise. Focus on mechanisms for controlling pathway flux; identification of rate-limiting steps; techniques for studying metabolism, and glucose, glycogen, and lipid metabolism in muscle response to exercise. 2 cr.
B. Regulation of mammalian cellular metabolism with focus on the influence of exercise on amino acid metabolism in liver and muscle, lipid mobilization and adipose tissue metabolism, hepatic gluconeogenesis, and mechanisms of exercise-induced fatigue. Prereq: general biochemistry and human anatomy and physiology or equivalent. 2 cr.

906. Methods in Protein Nutrition and Metabolism
Survey and evaluation of common techniques in the study of protein nutrition and metabolism. Prereq: ANSC 904. 2 cr. (Offered second half of the semester.)

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.)

911. Lipids
Structure, metabolism, and function of lipids of importance to animals. 2 cr. (Offered in alternate years.)

913. Contemporary Topics in Immunobiology
Topical lectures, seminars, and assigned reading emphasizing recent advances in immunology. May be repeated for a maximum of 4 credits. 2 cr. (Offered in alternate years.)

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.)

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

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, transposable elements biology, and molecular population genetics. Opportunities also exist for interdisciplinary research in marine biochemistry, biochemical nutrition, and cell biology in adjunct facilities on campus.

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 during the first year. 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. 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 the student by the faculty. The successful completion of these requirements will entitle the student to candidacy for the Ph.D. degree.

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 program. The results of this examination and the student’s academic record will be evaluated at this time to ascertain eligibility to proceed to candidacy in the doctoral program. Upon completion of graduate courses recommended by a guidance committee, 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.

804. Endocrinology

Structure and function of vertebrate endocrine systems. The influence of endocrine systems on the physiology of vertebrates, with special reference to mammals. Current investigations of the endocrine system as a regulator of body functions including such systems as growth, reproduction, metabolism, differentiation, and behavior. Prereq: general biochemistry or principles of biochemistry or permission. (Also offered as ZOOL 804.) 4 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 851/or permission. 3 cr.
895, 896. Biology Special Investigations
A. Teaching—teaching practicum in a biological science supervised by a biology faculty member. B. Research—research practicum in a biological science supervised by a biology faculty member. C. Special Topics—selected topics of current interest in biology. Lecture/discussion format. Prereq: 12 hr. of biology courses or permission. 1–4 cr.

897. Biology Masters Project
An independent project approved by student's master's program advisory committee. Requires written report and seminar presentation. Students should register for a total of 5 credits in 4 plus 1 sequence. 1–4 cr. Variable. IA.

Business Administration (ADMN)

Professors: Ahmad Etebari; Stephen L. Fink; John Freear; Lyndon E. Goodridge; Charles W. Gross; Jonathan Gutman; Francine S. Hall; James O. Horrigan; Fred R. Kaen; Marvin J. Karson; Allen M. Kaufman; Barry Shore; Linda G. Sprague

Associate Professors: John H. Barnett; Gene Bocciarelli; Ross J. Gittel; Lucy L. Henke; Jinoos A. Hosseini; Michael J. Merenda; Richard L. Mills; William Naumes; R. Dan Reid; Jeffrey E. Sohl; Allen R. Thompson; Rita Weathersby

Assistant Professors: Judith N. Bouley; Catherine A. Craycroft; Flora G. Guidry; Nancy L. Hansen; Patricia B. Smith; A. R. Venkatachalam; Craig H. Wood

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.

The mission of the Whittemore School of Business and Economics is to be a distinguished professional school in which the liberal arts are the basic foundation, and the management of change in a global economic community is the major emphasis.

In order to achieve this mission, the School is committed to the following goals:

1. The preservation of the unique disciplinary traditions in each of its departments and programs and the simultaneous commitment to broad educational excellence in critical thought, verbal and written communi-
cations, quantitative skills, computer literacy, and ethical reasoning.
2. The transmission, through excellent teaching, of basic and advanced education that prepares students for future careers in management, public service, research, and education, in which an understanding of business, economic, political, and social environments on both a national and global level are crucial requirements.
3. The production of prominent scholarship and research by its faculty.
4. The promotion of international awareness and cross-cultural understanding as an essential component of the educational experience of its students.
5. The integration of practice and theory in its educational process, the testing of its ideas in applied settings, and the guidance of its research by the acknowledged basic paradigms in its various disciplines.
6. The fostering of an environment that values collegiality, fairness, interdisciplinary activities, and continuous faculty development.
7. The encouragement of interaction with business and other external entities through such activities as research, consulting, executive development opportunities, mid-career learning programs, and other scholarly activities that contribute to life-long learning.

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 semester of calculus or have demonstrated proficiency in quantitative reasoning. Interested applicants are encouraged to contact George T. Abraham, Director of Graduate and Executive Programs, Whittemore School, 15 College Road, UNH, Durham, NH 03824-3593.

Day M.B.A. Degree Requirements
The Whittemore School curriculum for day students consists of an integrated sequence of twenty courses normally requiring two years of full-time study. During the first year, ten required courses in the basic disciplines and the functional areas of 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. In addition to electives offered by the departments in the Whittemore School, students are encouraged to undertake internships and appropriate graduate-level courses offered by other departments within the University.

Curriculum
First Year
Semester I
Financial Accounting
Managerial Statistics
Economics
Organizational Behavior
Managerial Accounting
Management Information Systems
Marketing
Second Year
Semester I
Financial Management
Operations Management
Empirical and Modeling Methods in Business
Marketing
Semester II
Managerial Accounting
Financial Management
Operations Management
Empirical and Modeling Methods in Business
Marketing

Executive M.B.A. Requirements
The curriculum for practicing managers contains the same 15 core course requirements as the day M.B.A. as well as a required Integrative Management Seminar that runs throughout the program and 3 elective courses. The curriculum is tailored and scheduled to meet the needs of those individuals 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 and strategic 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.

Curriculum
First Year
Term 1 (Sept.-Dec.)
Financial Accounting
Managerial Statistics
Organizational Behavior
Integrative Management Seminar
Term 2 (Jan.-Apr.)
Empirical Modeling and Methods in Business
Management Information Systems
Marketing
Integrative Management Seminar
Term 3 (Apr.-June)
Managerial Accounting
Economics
Operations Management
Integrative Management Seminar
Summer
Research Project (optional)

Second Year
Term 1 (Sept.-Dec.)
Financial Management
Organizational Theory
1 elective
Integrative Management Seminar
Term 2 (Jan.-Apr.)
Strategic Marketing
Business, Government, and Society
1 elective
Integrative Management Seminar
International Residence (optional)
Term 3 (Apr.-June)
Financial Policy
Strategic Management: Decision Making
1 elective
Integrative Management Seminar
International Residence
During the second year of study, via case studies, guest presenters, and optional ten-day international residence, the curriculum
will address the issues of global competition. While guest presenters and case studies will be scattered throughout the year, the international residence will take place in April. All 800-level courses require permission of the instructor or graduate program office.

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. Management Skills
Focuses on the role of the manager, particularly the interpersonal competencies required to work effectively with superiors and subordinates. Participants develop and critique their behavior in situations that involve interviewing, listening, delegation, conflict management, performance appraisal, and handling problem employees. May include writing, presentations, field study, and video taping. 3 cr.

814. Personal Values, Organizational Conflict, and Business Ethics
Analyzing the procedures and objectives of capitalism, the relationship between organizational goals of the business and the values of both the individual manager and society, and the assumptions and conceptual foundations of ethical theory and moral philosophy. 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 managerial accounting/or permission. 3 cr.

822. Advanced Cost Accounting
Effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Analysis of cost behavior, direct and absorption costing, cost-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, databases, and expert systems. Use of mainframe 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.

836. Financial Statement Analysis
The empirical properties of financial statement data and evidence of its ability to predict such events as security returns, corporate restructuring, debt ratings, and financial distress. An empirical research project using computer data banks is required. 3 cr.

837. Financial Accounting Theory and Applications I
Theory and practice of income measurement and asset valuation; consolidations, partnerships, leases, pensions, price-level reporting, foreign currencies, and fund accounting. 3 cr.

839. Financial Accounting Theory and Applications 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. Prereq: ADMN 940. 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 on 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 judgment 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. Topics in 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.

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.

854. Seminar in Accounting and Finance
Seminar discussions of advanced readings in accounting and finance. For second-year M.B.A. students. 3 cr.

858. Strategic Management of Operations
Review and application of operations management techniques and methodologies for the development of operations strategies. Team projects with client firms including operations analyses leading to recommendation for developing the firm's strategic operations posture. Prereq: ADMN 940. 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
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. (Executive M.B.A. Program only.)

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. Cr/F. (Can be repeated.)

920. Financial Accounting
Introduction to the accounting methods employed in organizations to determine and communicate their financial positions to interested parties outside the organization. 3 cr.

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

925. Advanced Organization Theory
Examines organizations as complex social systems, focusing on organizational structures as they relate to various functions, including rewards, controls, and decision making. Emphasis placed on the design of organizations for the future with special attention to rapid changes in technology and environmental factors. 3 cr.

926. Management Information Systems
Provides students with the background to understand, develop, and use computer-based information systems in organizations. Five major topics are covered including: the information system framework; information technology; application software for managers; applications development; and management of information systems resources. The application software component covers the use of spreadsheets and relational database systems. Students participate in groups and are required to make several presentations during the semester. Prereq: M.B.A. students. 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.

935. Financial Policy
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.

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.
955. Quantitative Methods
Examines the role of quantitative models in the decision-making environment. Topics include regression analysis, forecasting, and management science models. Major emphasis is on the theoretical development of the model and the application to business decision making. 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.

965. Strategic Marketing
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.

970. Economics
An introduction to micro- and macroeconomic principles and their application to business. Topics include consumer theory, production and cost, market structures, gross national product, monetary and fiscal policy, and international trade and finance. 3 cr.

981. Business, Government, and Society
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 6 credits, except by special permission. Variable credit. 1-6 cr.

Chemical Engineering (CHE)

Chairperson: Stephen S. T. Fan
Professors: Stephen S. T. Fan; Ihab H. Farag; Virendra K. Mathur; Gael D. Ulrich
Associate Professors: Dale P. Barkey; Russell T. Carr; Donald C. Sundberg
Assistant Professor: Palligarmi 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 degree in chemical engineering. The core courses required 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. (Not offered every year.)

809. Fundamentals of Air Pollution and Its Control

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. (Not offered every year.)

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: 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. Application 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, adsorption and aeroplant. Applied fluid mechanics, mass transfer, and kinetics. Thermal pollution, chemical treatment, oil spills, oil, 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 multi-bubbles in fluidized beds. Heat and mass transfer and gas-solid reactions in fluidized beds. Applications in design of noncatalytic reactors and heat transfer equipment. 3 cr. (Not offered every year.)

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 multicomponent 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.

899. Master's Thesis
Variable credit; 6 credits required.

999. Doctoral Research

Chemistry (CHEM)
Chairperson: Paul R. Jones
Professors: Kenneth K. Andersen; N. Dennis Chasteen; Colin D. Hubbard; Richard P. Johnson; Paul R. Jones; James D. Morrison; W. Rudolf Seitz; James H. Weber; Edward H. Wong
Associate Professors: Christopher F. Bauer; Howard R. Mayne; Roy P. Planalp; Sterling A. Tomellini; Gary R. Weisman
Assistant Professors: Chifuru Noda; Charles K. Zercher
Graduate Program Coordinator: Howard R. Mayne
Graduate Admissions Committee Chair: Roy P. Planalp

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 dissertation. Ph.D. students 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. Students will also demonstrate to the guidance committee that they have a broad basic knowledge of the field of chemistry: (1) by completing certain fundamental graduate courses; (2) by means of a series of examinations in the major field; and (3) by presenting and defending an original research proposal before the end of the third year (CHEM 907). The culmination of the program will result in a public defense and acceptance of the dissertation.

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 de-
partments. 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 re-
search problem appropriate to interdis-
ciplinary treatment. Students interested
in these programs should write to the
graduate coordinator for further infor-

teaching Requirement
All graduate students who are doctor of
philosophy or master of science can-
dates will obtain some teaching experi-
ence during their tenure.

Analytical Chemistry
862. Instrumental Methods of Chemical
Analysis
Theory, instrumentation, and application of
methods such as atomic absorption, cou-
lometry, emission spectrography, gas and
liquid chromatography, polarography,
potentiometry, IR and UV-Vis absorption
spectrophotometry, and mass spectrometry
to chemical analysis. Prereq: quantitative
analysis; phys. chem. as a pre- or
co-requisite; or permission. 3 cr.

930. Advanced Optical Methods
Techniques of chemical identification and
analysis utilizing optical instrumentation
from the standpoint of theory and applica-
tion. Topics include UV-visible absorp-
tion, luminescence, atomic spectroscopy, IR,
nuclear magnetic resonance (NMR), x-ray methods, and mass spectrometry. Prereq: CHEM 935 or permission. 3 cr. (Not offered every year.)

931. Advanced Electrochemical
Methods
Theory and application of important elec-
trochemical techniques such as potenti-
ometry, polarography, and voltammetry.
Prereq: CHEM 935 or permission. 2 cr. (Not offered every year.)

932. Statistics and Experimental Design
Confidence intervals, analysis of variance,
regression analysis, sampling statistics, op-
timization procedures. Examples drawn pri-
marily from the analytical chemistry litera-
ture. 2 cr. (Not offered every year.)

933. Chemical Separations
The use of various separation techniques
prior to analysis; separations as methods of
analysis. Prereq: CHEM 934 or permission.
3 cr. (Not offered every year.)

934. Chemical Equilibria
Formulation and solution of chemical equi-
lbrium problems of relevance to analytical
chemistry, particularly multiphase separa-
tions. 2 cr. (Not offered every year.)

935. Analytical Instrumentation
Introductory electronics for chemists. Em-
phasis placed on how electronic components
and circuits affect acquisition, manipula-
tion, and quality of chemical information.
Includes optical transducers and detectors
and signal processing. 3 cr.

Inorganic Chemistry
874. Inorganic Chemistry
Basic theoretical concepts and their appli-
cations to inorganic reactions and compounds. Prereq: organic chemistry, physical
chemistry; or permission. 3 cr.

903. Advanced Inorganic Chemistry I
Survey of important concepts of modern
inorganic chemistry. 4 cr.

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

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

Organic Chemistry
855. Intermediate Organic Chemistry
An overview of organic chemistry at the
intermediate levels. Aspects of synthetic
organic chemistry and physical organic
chemistry, including stereochemistry are
covered. 3 cr.

901. Physical Organic Chemistry
Advanced treatment of organic reaction
mechanisms, theoretical organic chemistry,
organic stereochemistry, and other topics.
Fourth hour problem session. 4 cr.

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

911. Organic Synthesis
Fundamentals of synthetic organic method-
ology and applications in multiple synthe-
ses. Fourth hour recitation session. 4 cr.

917, 918. Special Topics in Organic
Chemistry
Advanced courses dealing with specialized
subdisciplines of organic chemistry. 2–4 cr.

Physical Chemistry
876. Physical Chemistry III
Application of quantum theory to atomic
electron structure, spectroscopy, and mole-
cular structure. Lab. 4 cr.

905. Advanced Physical Chemistry I
Introduction to topics in quantum mechan-
ics and group theory, which form the back-
ground of all areas of modern chemistry.
4 cr.

906. Advanced Physical Chemistry II
Wave mechanics and quantum chemistry,
spectroscopy, molecular structure, and sta-
tistical thermodynamics. Prereq: one year
of physical chemistry. 3 cr.

#921. Physical Chemistry—Chemical
Kinetics
The kinetics of homogeneous and heteroge-
neous reactions in gaseous and liquid sys-
tems, including an introduction to very
rapid reactions. Prereq: one year of physi-
cal 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. Physical Chemistry of Solutions
Thermodynamics and kinetics of solution
chemistry. 3 cr.

927, 928. Theoretical Chemistry I, II
The modern concepts and mathematical
formalism of quantum mechanics and appli-
cations 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,
termolecular forces, and chemical kinetics.
May be offered as a tutorial. Prereq: per-
mission. 3 cr. (Not offered every year.)

General Offerings
Courses in which all areas of specialization
participate.

808. Research Techniques
Selected instrumental and chemical meth-
ods used in chemical research for the sepa-
rations, identification, and structural analy-
sis of chemical compounds. Typical topics
include mass spectroscopy, NMR spectros-
cy, IR and UV spectroscopy, and chro-
matographic methods. 1–4 cr.

907. Introduction to Research
Introduces the doctor of philosophy student
to the planning, experimental methods, and
interpretation of a research problem. Stu-
dent presents and defends an original re-
search proposal before a faculty committee.
Must be completed satisfactorily by all doc-
toral students. Cannot be used for credit by
master of science candidates. 2 cr.
908. Applied Multinuclear Magnetic Resonance Spectroscopy
Survey of basic theory, instrumentation, and practical techniques of NMR spectroscopy; interpretation of 1D and 2D hydrogen-1 and carbon-13, and multinuclear NMR spectra of organic, inorganic, and organometallic compounds in the solution of problems of structure and dynamics. Prereq: a knowledge of basic NMR at the undergraduate level. 3 cr.

995, 996. Colloquium in Chemistry
A) Inorganic Chemistry; B) Organic Chemistry; C) Theoretical Organic Chemistry; D) Physical Chemistry; E) Analytical Chemistry; F) Chemical Education. 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: Thomas P. Ballester
Professors: David L. Gress; Otis J. Sproul
Associate Professors: Thomas P. Ballester; Jean Benoit; Michael R. Collins; Pedro A. de Alba; Charles H. Goodspeed; Robert M. Henry; Nancy E. Kinney; Paul J. Ossenbruggen
Research Associate Professor: T. Taylor Eighmy
Assistant Professor: James P. Malley
Graduate Program Coordinator: Jean Benoit

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. 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 order 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. System Analysis II
Methods of analysis for decision making used in planning, design, and management of various engineering systems involving chance and uncertainty. Topics in applied probability and statistics are used for risk analysis and for investigating system performance and reliability. Prereq: systems analysis, probability and statistics for applications, or permission. 3 cr.

839. 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: systems analysis, fundamental aspects of environmental engineering, or 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 septic treatment. Prereq: fundamental aspects of environmental engineering or permission. 3 cr.

841. Open-Channel Flow
Energy and momentum principles in open-channel flow; flow resistance; channel controls and transitions; unstable 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: fundamental aspects of environmental engineering or permission. 3 cr.

845. Engineering Hydrology
Hydrologic cycle, probability theory related to hydrology and the design of water resources structures, flood discharge prediction, hydrograph development, hydrologic and hydrologic river routing, reservoir routing, theory of storage, reservoir operations, hydropower development, multipurpose projects. Prereq: permission. 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 ra-
dioactive wastes; and oil spills. Prereq: fundamental aspects of environmental engineering or permission. 3 cr.

848. Solid Waste and Residuals Management
Focuses on collection, characterization, treatment, and disposal of solid waste and residuals (sludges) from environmental treatment processes. Topics include waste minimization, sludge stabilization, thickening, dewatering, composting, codisposal, landfill design, and incineration. Prereq: fundamental aspects of environmental engineering or permission. 3 cr.

849. Water Chemistry
Emphasizes the use of chemical equilibrium principles. Theory, calculations, and applications of ionic equilibrium stresses. Topics include thermodynamics, kinetics, acid/base, complexation, precipitation/dissolution, and redox equilibria. Computer equilibrium modeling is presented. Prereq: general chem. or equivalent. 4 cr.

854. Transportation Engineering and Planning
Fundamental relationships of traffic speed, density, and flow applied to public and private modes of transport. Principles of demand forecasting and urban systems planning. Prereq: permission. 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 examine these concepts. Prereq: fundamental aspects of environmental 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 Design
Subsurface investigation and characterization using current methods of laboratory and in situ testing. Bearing capacity theory and design of shallow foundations including footings and rafts. Design and analysis of deep foundations including piles, piers, and caissons. 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 cut-offs. Slope stability theory and applications. Prereq: soil mechanics or permission. 4 cr.

862. Introduction to Geotechnical Earthquake Engineering
Overview of earthquake source mechanisms; magnitude and intensity; seismicity of the U.S.A. Dynamics of simple structures; response spectra. Selection of design parameters; source, magnitude, input records. Measurement of dynamic characteristics of soils; site response, liquefaction, and ground deformation. Prereq: CIE 860 or permission. 3 cr.

863. 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.

#865. Soil and Site Improvement
Techniques for improving support and behavior characteristics of soils. Includes in situ reinforcement, densification, reinforcement of constructed earth, and chemical admixtures and grouting. Prereq: CIE 860. 3 cr.

874. Reinforced Concrete Design I
Introduction to the design of reinforced concrete structural members by the ACI strength design method. Includes beams, columns, 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, development of finite element theory, and modeling techniques. Applications in solid mechanics, heat transfer, fluids, and dynamics using commercially available codes. Prereq: classical structural analysis, matrix algebra, or permission. 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, members, columns, beams, plate girders, bolted joints, 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.

#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. Advanced Hazardous Waste and Environmental Sampling and Analysis
Laboratory and field techniques for the sampling and analysis of hazardous waste. Lecture covers theory behind techniques. Prereq: gen. chem.; systems analysis; and fundamental aspects of environmental engineering. Lab. 4 cr.

944. Advanced Physicochemical Treatment Design
Theoretical and experimental examination of physicochemical treatment processes. Discusses design, application, and operational principles associated with gas transfer, coagulation, particle-liquid separation, absorption, water stabilization, chemical precipitation, and disinfection unit processes. Stresses the knowledge of laboratory applications. Prereq: fundamental aspects of environmental engineering; CIE 849; or permission. 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: ground water hydrology. 3 cr.

946. Advanced Biological Treatment Design
Theoretical and experimental examination of the fundamental parameters used in selection, design, and operation of biological treatment processes for waters, wastewaters, and hazardous wastes. Topics include design and evaluation of aerobic and anaerobic processes, suspended and fixed-film processes, and advanced biological water and wastewater treatment processes. Prereq: CIE 856; CIE 943; or permission. 4 cr.

#949. Aquatic Chemistry
Emphasizes the use of chemical equilibrium principles to provide an understanding of the chemistry of surface waters, ground waters, and unit operations and processes in environmental engineering. Topics include surface and colloid chemistry, acid-base reactions, oxidation-reduction, dissolution-precipitation, and coordination chemistry. Prereq: CIE 849 or permission. 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, local 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 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
Professor: Stephen N. Calculator
Associate Professors: Stephen P. Bornstein; Frederick C. Lewis
Assistant Professors: Susan Dietrich; Penelope E. Webster
Graduate Program Coordinator: Stephen P. Bornstein

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 Hearing Association in the area of speech pathology. The
master of science degree program is accredited by the American Speech-Language Hearing Association.

Admission Requirements

Applicants for admission should possess a bachelor's degree in communication disorders or its equivalent, including coursework equivalent to the UNH bachelor of science curriculum in communication disorders. Applicants must submit Graduate Record Examination general test or Miller Analogies Test scores.

Students without an undergraduate degree in speech pathology must take the required undergraduate communication disorders courses before beginning graduate work. Students who fall under this criterion may apply for admission to the Graduate School or take undergraduate courses through the Division of Continuing Education.

M.S. Degree Requirements

Required Courses The following courses are required of all students: PHED 806, Neurology; COMM 900, Articulatory and Phonological Disorders in Children; 902, Stuttering; 904, Aphasia in Adults; 905, Motor Speech Disorders; 906, Voice Disorders; 907, Advanced Seminar in Aural Rehabilitation; 908, Language and Learning Disabilities in School-Age Children; 909, Orofacial Anomalies; 910, Clinical Practicum; 911, Off-Campus Clinical Practicum; 912, Language Disorders in Early Childhood; EDUC 981, Methods and Techniques of Educational Research; 920, Seminar (at least 2 credits).

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 meet academic and clinical requirements for certification by the American Speech-Language Hearing Association.

Clinical Practicum The specific number of credits needed by a student will depend on undergraduate program and experience. Students must meet the practicum requirements for certification by the American Speech-Language Hearing Association, including practicum in at least three different practicum sites.

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. Articulatory and Phonological Disorders in Children 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 on clinical management. Prereq: speech pathology II or permission. 3 cr.

904. Aphasia in Adults Principles concerning etiologies, evaluation, classification, and methods of clinical management including the team approach to rehabilitation of aphasia in adults. Prereq: PHED 806. 3 cr.

905. Motor Speech Disorders Neurological bases, diagnosis, and treatment of motor speech disorders including cerebral palsy, acquired dysarthria, and apraxia of speech. Prereq: PHED 806/or permission. 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.

#907. Advanced Seminar in Aural Rehabilitation Current issues in therapeutic techniques and management considerations for the hard-of-hearing child. Speech perception by the hearing impaired, use of amplification systems, counseling approaches, and modification of the listening environment and language considerations, and the development of IEPs. Prereq: basic audiology; introduction to auditory perception and aural rehabilitation, speech and hearing science; or equivalent. 3 cr.

908. Language and Learning Disabilities in School-Age Children Examination of language-based learning disabilities; relation between language and learning; current assessment and treatment strategies. Prereq: permission. 3 cr.

909. Orofacial Anomalies Etiological and therapeutic considerations of orofacial pathologies with emphasis on cleft lip and palate. Prereq: anatomy and physiology of the speech and hearing mechanisms or its equivalent. 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—a minimum of 3 credits is required for the M.S. degree.) 3 cr.

911. Off-Campus Clinical Practicum Application of advanced theoretical knowledge in an off-campus clinical setting. Prereq: permission. Two practicum experiences are required for 3 credits each.

912. Language Disorders in Early Childhood Transdisciplinary examination of interrelationships between early language, social, and cognitive development with emphasis on collaborative models of assessment and intervention. Reviews implications for special populations (e.g., mentally retarded,
autistic, sensory impaired, and limited English proficiency). 3 cr.

920. Graduate Seminar
Current topics, recent investigations, and library research. (May be repeated up to 9 credits barring duplication of subject matter.) A minimum of 2 credits is required for the M.S. degree. 1–6 cr.

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

**Computer Science (CS)**

**Chairperson:** T. M. Sparr  
**Professors:** R. Daniel Bergeron; Eugene C. Freuder; Shan S. Kuo; T. M. Sparr  
**Associate Professors:** Philip John Hatcher; Robert D. Russell; James L. Weiner  
**Adjunct Associate Professor:** Sylvia Weber Russell  
**Assistant Professors:** Pilar de la Torre; Raymond Greenlaw; Elise H. Turner  
**Research Assistant Professor:** Roy M. Turner  
**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 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.

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). 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 900 (a 1-credit graduate seminar). The thesis option requires eight additional courses numbered 800 or above (three must be above 900), plus 6 credits of thesis work. The nonthesis option requires ten additional courses numbered 800 or above (four must be above 900) distributed among five subject categories, and a comprehensive written examination.

**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 sixteen semester courses (of at least 3 credits each) beyond the bachelor's degree, or eight 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.

Every doctoral student must pass a written qualifying exam consisting of two major components: a breadth requirement and a depth requirement. The breadth requirement consists of a written examination covering four major areas of computer science. The depth requirement has three parts: a written survey of relevant literature, a written research report focused on an area of research, and an oral examination.

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, non-trivial programming language and to design and implement its compiler. Prereq: prog. lang. concepts and features. 3 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: data structures. 3 cr.

819. Object-Oriented Methodology
Object-oriented system design. Object-oriented programming. Languages for object-oriented programming. Prereq: strong programming skills; experience with C programming is highly desirable. 3 cr.

820. Operating System Concepts
Theory and practice of building operating systems. In-depth investigation of operating system concepts and design. Development from current operating systems (e.g., UNIX, DOS, OS/2). Examples from industry are emphasized. Prereq: operating system fundamentals or equivalent. 3 cr.

822. Advanced Systems Programming
Topics in systems programming, including organization and implementation of editors, text processing utilities, command language decoders, and file systems. Prereq: operating system fundamentals. 3 cr.
827. Computer Communications Software Design

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. 3 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. 3 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.) 3 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.) 3 cr.

865. Introduction to Computational Linguistics
Introduction to computational analysis of natural language, with a focus on semantic representations and the resolution of ambiguity. Provides an elementary working knowledge of linguistic and artificial intelligence analysis methods as motivated by examples of potential input text. Topics include parsing, formal grammars, representation of knowledge and memory, inference, and interpretation of nonliteral language. Prereq: elementary knowledge of LISP or permission. 3 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: data structures. 3 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. 3 cr.

880. Topics in Computer Science
Material not normally covered in regular course offerings. May be repeated for credit. 3 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.

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 820 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: operating system fundamentals. 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.

941. Design and Analysis of Algorithms
Principles of design of efficient algorithms. Methods studied include recursion, divide and conquer, dynamic programming, greedy techniques, and data structure selection. Correctness and analysis of algorithms. Examples are drawn from problems in the areas of graphs, sorting, searching, pattern matching, and polynomials. Prereq: undergraduate algorithms course recommended. 3 cr.

942. Parallel Computers and Computations

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.

959. Theory of Computation
Models of computation, Church's thesis, completeness, undecidability. Time and space complexity of Turing machines. Savitch's theorem and hierarchy theorems. NP-completeness and Cook's theorem. Prereq: introduction to the theory of computation or equivalent. 3 cr.

970. Advanced Computer Graphics
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 875 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, natural resources, 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 (either of two tracks: biogeochemistry or climate change), the specialization in space physics in physics; and through the departmental (M.S.) or intercollege (Ph.D.) program in natural resources. 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 the graduate program descriptions in earth sciences, natural resources, and physics for admission and degree requirements.

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 thermostat; 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.

812. Physics of the Ionosphere
Introduces basic plasma physics using a case study of the Earth's ionosphere and its connection both to the upper atmosphere and to the Earth's magnetosphere. Topics include single particle motion, fluid and kinetic descriptions of ionospheric plasma, wave propagation, and instabilities. Prereq: electric and magnet. I or equivalent; Calculus II. (Also offered as PHYS 812.) 4 cr.

813. Biogeochemical Dynamics
Examines the influence of biological processes on geochemical transformations and elemental cycles from the molecular to the global scale involving microorganisms and higher plants and animals; factors that regulate cycles; interactions among biosphere, hydrosphere, lithosphere, and atmosphere; transformations of sulfur, nitrogen, and carbon. 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 observations 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.

860. 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 demonstrate the important principles. Prereq: college physics and differential equations or permission. 3 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, oceans, and space science and engineering, students are expected to contribute to a discussion of current topics of interest in the literature. 1 cr. Cr/F.
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 equilibrium; quasi-geostrophic flow; waves (acoustic-gravity, planetary, magnetopause); solar-wind dynamics; instabilities (convective, baroclinic); Hall layers; tearing modes; resonant absorption; supersonic flows; and energy through such systems. (Normally offered every other year.) Prereq: PHYS 941, 942, and 944. (Also offered as PHYS 988.) 3 cr.

987. Magnetospheres
Introduces plasma physics of the interaction of solar and stellar winds with planets having internal magnetic fields, most predominantly, the Earth. Both MHD and kinetic descriptions of internal and boundary processes of magnetospheres as well as treatment of the interaction with collisional ionospheres. Flow of mass, momentum, and energy through such systems. (Normally offered every other year.) Prereq: MATH 845 and 846, or PHYS 931. (Not offered every year.) (Also offered as PHYS 955.) 3 cr.

988. High Energy Astrophysics
One-semester course on the physical principles underpinning the field of high energy astrophysics. Subjects covered include production, detection, and transport processes of neutral and charged high energy particles and photons. Emphasizes the applications of these processes to the detection and measurement problem and theory of telescope design. Uses astrophysical examples to illustrate the subject matter. First part serves as a basis for discussing the astrophysics of the heliosphere, including solar flares, galactic and solar cosmic rays, and the influence of the Earth's magnetic field on the cosmic rays. (Normally not offered every year.) Prereq: PHYS 951, 952, or permission. (Also offered as PHYS 987.) 3 cr.

Earth Sciences (ESCI)

Chairperson: S. Lawrence Dingman
Professors: Franz E. Anderson; Francis S. Birch; Wallace A. Bothner; Wendell S. Brown; S. Lawrence Dingman; Henri E. Gaudette; Robert C. Harriss; Paul A. Mayewski; Herbert Tischler
Adjunct Professors: Eugene L. Boudette; Anthony Jack Gow; Lincoln R. Page
Associate Professors: Jo Laird; Theodore C. Loder III; Karen L. Von Damm
Research Associate Professors: Patrick M. Crill; Mark E. Hines; Robert W. Talbot
Adjunct Research Associate Professors: David A. Gust; William Berry Lyons; Neal R. Pettigrew
Research Assistant Professors: Jack E. Dibb; Charles J. Vorosmarty; Larry G. Ward; Gregory A. Zielinski
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 and specialization at the Ph.D. level.

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, continental margin processes and environments, and mid-ocean ridges.

The hydrology specialization 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; biogeochemistry; and climate change. 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. 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,
Earth Sciences

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, Geologic 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 preliminary examination, given generally after one year of study; (3) pass a qualifying examination, given generally after two years of study; (4) have teaching experience equivalent to at least half time for one year; (5) complete significant original research presented in a dissertation; and (6) pass an oral defense of that work.

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

#803. Fluvial Hydrology
Mechanics of natural open-channel flows: forces, the continuity and energy principles, velocity distributions, flow resistance, fluvial erosion and sediment transport, channel form, computation of flow profiles, weirs, hydraulic jumps, and streamflow routing. Lab and field exercises. Prereq: one year each of calculus and physics. 4 cr.

805. Principles of Hydrology
Physical principles important in the land phase of the hydrologic cycle, including precipitation, snow-melt, infiltration and soil physics, and surface and subsurface flow to streams. Problems of measurement and aspects of statistical treatment of hydrologic data. Field trips. Transportation fee.

808. Hydrology and Water Resources
Interrelations of hydrologic data and analysis with the environmental, economic, and legal aspects of water resources management. Examines local, national, and global water-resource problems. Prereq: ESCI 805; basic statistics/or permission. 3 cr. (Offered alternate years.)

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 evolution of igneous rocks as determined from field, petrographic, chemical, experimental, and theoretical studies. Application of thermodynamics to igneous petrogenesis. Physical properties of magmas. Prereq: mineralogy; petrography; adequate background in calculus, chemistry, and physics. Field trips. Special fee. Lab. 4 cr. (Offered alternate years with ESCI 826.)

826. Metamorphic Petrology
The metamorphism of pelitic, mafic, and calc silicate rocks as determined from field, petrographic, mineral chemistry, experimental, and theoretical studies. Closed- and open-system reactions, multisystems, reaction space. Calculation of pressure, temperature, time paths. Prereq: mineralogy; petrography; adequate background in calculus, chemistry, and physics. Field trips. Special fee. Lab. 4 cr. (Offered alternate years with ESCI 825.)

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 and electrical 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.

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.)

847. Aquatic 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 CO2-CaCO3 system, the formation and dissolution of salts and authigenic mineral formation. Prereq: one year of chem. or geochem.; or permission. 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 A. 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 aboard R/V Jere A. Chase. Prereq: permission. Lab (optional). 3 or 4 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 is primarily 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, including the salt marsh environment. Includes independent field research project in the student’s area of interest. 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. 3 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.

895, 896. Topics in Earth Sciences
Study on an individual or group basis in geologic, hydrologic, or oceanographic problems, under members of the graduate staff. Topics include: geochemistry, geomorphology, geophysics; glaciology; groundwater; structural, and regional geology; crystallography; mineralogy; petrology; thermodynamics; ore deposits; earth resource policy; paleontology; sedimentation; stratigraphy; water resources management; chemical, physical, and geological oceanography; earth systems; earth science teaching methods. Prereq: permission of staff concerned. 1-4 cr. (May be taken more than once.)

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 groundwater. 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.)

934. Advanced Applied Geophysics
Exploration methods including gravity, magnetics, electromagnetics, 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.)

959. Data Analysis Methods in Ocean and Earth Sciences
Methods of analysis of oceanographic, geochemical, 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. 4 cr.

962. Glaciology
Physical principles controlling glacier activity and their 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.)

996. Advanced 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, 896. Prereq: permission of staff concerned. 1-4 cr. (May be taken more than once.)

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

with sedimentation concepts. Field project directed toward prethesis research. Prereq: ESCI 854 and 856/or permission. 2-4 cr. (Not offered every year.)

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 is treated in detail. Prereq: ESCI 858; ME 807/or permission. 3 cr. (Not offered every year.)

Earth Sciences
Economics (ECON)

Chairperson: Richard W. England
Professors: Robert C. Puth; Evangelos O. Simos
Associate Professors: Karen Smith Conway; Richard W. England; Marc W. Herold; Richard L. Mills; Neil B. Niman; Allen R. Thompson; James R. Wible
Adjunct Associate Professors: Ralph B. Bristol, Jr.; Evangelos Charos
Assistant Professors: William D. Bradford III; Bruce T. Elmslie; Michael D. Goldberg; Torsten Schmidt; Stanley A. Sedo

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 alternative 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. The Ph.D. program is currently under review. Certain courses and/or requirements may be changed.

The economics program is offered through the Whittemore School of Business and Economics. The school's mission statement can be found under the M.B.A. program description.

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. These courses must be ECON 972 (Macroeconomics I), ECON 976 (Microeconomics I), and ECON 926 (Econometrics I);
   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 alternative economic theories. At least three electives from a prescribed list are required by each concentration. Further information about concentrations can be obtained from the department chair. A concentration is not required.

Ph.D. Degree Requirements

Ph.D. candidacy requires the following:

1. Completion of core courses:
   - Microeconomics I and II
   - Macroeconomics I and II
   - Econometrics I and II
   - History of Economic Thought
   - Topics in Economic Thought and Methodology;
2. Comprehensive exams in microeconomics and macroeconomics;
3. Completion of an applied area of concentration (three courses);
4. Participation in the General Economics Seminar for three semesters or more;
5. Participation in a research workshop for three semesters or more;
6. Demonstrated knowledge of one foreign language; and
7. An accepted dissertation proposal.

There are eight core courses in the program. The two theory exams may be taken separately. The applied area of concentration consists of three closely related courses chosen by the student with the approval of the faculty. Research workshops typically offered, although not all at once, are macroeconomics, econometrics, resource economics, finance, labor economics, international development, and political economy. A continuously integrated approach to research is a highlight of the program. Early in their program, students attend the General Economics Seminar where nearly finished work is presented. Later, students enroll in a research workshop where research in progress is presented. Research workshops are intended to launch the student into the dissertation. The student's formal presentation of a dissertation proposal takes place in a research workshop.

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

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 and environmental impact of technology transfer to less-developed nations. 4 cr.

811. Economic Fluctuations
Recurrent movements of prosperity and depression; emphasis on causes and policy implications. 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. 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; non-economic factors. 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.
828. Time Series Analysis
Examines the role of time series in forecasting. Studies modern time series models, with particular emphasis on Box-Jenkins methods. Prereq: introductory statistics. (Also offered as ADMN 842.) 3 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. 4 cr.

836. Seminar in Monetary Theory and Policy
Contemporary developments in monetary theory and the evaluation of policy measures. 4 cr.

841. Introduction to Public Policy
Explores the basic issues of public sector economics and emphasizes the use of economic theory in predicting the effects of public policy on individual behavior and the overall economy. Specific topics include market failures, collective decision making, cost/benefit analysis, and an evaluation of tax and transfer programs. 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. 4 cr.

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

#874. Economic Dynamics
Use of difference and differential equations for analysis of dynamic properties of single-equation and system-wide models in micro- and macroeconomics. Economic and business applications of optimization over time using advanced mathematical techniques such as calculus of variations and control theory. Prereq: Mathematical Economics, Macroeconomics I, Microeconomics I. 4 cr.

#878. Economics of Centralized and Mixed Systems
Origins of planning; planning agriculture and industry; growth models; input-output and material balances; optimal planning; value and prices in socialist economics; economic reforms and mixed systems; and theories about the nature of socialist societies. Mechanisms of centralized planning in their sociohistorical context. Prereq: Macroeconomics I; Microeconomics I or permission. 4 cr.

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

926. Econometrics I
Application of statistical and econometric methods to problems in economics. Topics: basic statistical theory, simple and multiple regression, violations of the basic assumptions, generalized least squares, and introduction to simultaneous equation models. Prereq: undergraduate statistics course. 4 cr.

927. Econometrics II
Simultaneous equation models, nonlinear estimation, qualitative and limited-dependent variables, distributed lag models, introduction to time series (ARIMA) models, pooling of cross-section and time series models. Prereq: Econometrics I or its equivalent. 4 cr.

957. History of Economic Thought
Traces the development of economic thought, with careful examination and critical appraisal of the contributions made by important figures and schools of thought. 4 cr.

958. Topics in Economic Thought and Methodology
Advanced seminar in a selected topic in economic thought or methodology. 4 cr.

972. Macroeconomics I
Development of the major macro models and approaches to macroeconomics: classical, Keynesian, Monetarist, New Classical, and New Keynesian models and views. An introduction to open economy macro models. 4 cr.

973. Macroeconomics II

976. Microeconomics I
Survey and applications of modern microeconomic theory. Analysis of households, firms, product and resource markets, public goods, and behavior under uncertainty. 4 cr.

977. Microeconomics II
Analysis of stability, cooperative and non-cooperative game theory, information economics, exhaustible resources, disequilibrium, public choice, and input-output analysis. Prereq: Microeconomics I. 4 cr.

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

995. Independent Study
Prereq: permission of adviser and instructor. 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: Susan D. Franzosa
Professors: Michael D. Andrew; Angelo V. Boy; Jane A. Hansen; David J. Hebert; Barbara Houston; John H. Lawson; Dale F. Nitzschke
Associate Professors: Charles H. Ashley; John J. Carney; Grant L. Cioffi; Ellen P. Corcoran; Ann L. Diller; Janet Elizabeth Falvey; Susan D. Franzosa; Virginia E. Garland; Judith A. Kull; Bruce L. Mallory; Rebecca S. New; Jane E. Nisbet; Sharon N. Oja; M. Daniel Smith; Joan D. Stipetic; Dwight Webb
Adjunct Associate Professor: Richard H. Goodman
Assistant Professors: Richard M. Barton; Todd A. DeMitchell; Georgia Kerns; Ann A. Loranger; Joseph J. Onosko; Pearl M. Rosenberg; Paula M. Salvio; Thomas H. Schram; Herbert Wagner III; William L. Wansart
Graduate Program Coordinator: Todd A. DeMitchell

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 education), counseling, 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 educational administration and supervision. The doctor of philosophy is offered in education and in reading and writing instruction.

The master of science for teachers is offered in educational administration and supervision, counseling, early childhood education, and reading. They are offered through the departments of education, English, and mathematics.

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.

Individual programs within the department may have additional admissions requirements. Applicants should refer to specific program descriptions. 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 education and reading/writing instruction are acted on only in April. [The middle 50 percent of students admitted to all graduate programs in education during the years 1990 to 1993 scored between 460 and 610 on the verbal section of the GRE, 470 to 620 on the quantitative section, and 490 to 630 on the analytical section. They also had an average undergraduate grade-point average between 2.85 and 3.39.]

Doctor of Philosophy in Education

Program Information: Ann Diller

The Department of Education offers the degree of doctor of philosophy in education. The Ph.D. in education provides students with the experience necessary for distinguished leadership in a variety of settings. The course of study prepares students to serve as coordinators and administrators in school settings or state departments of education, faculty at colleges and universities, and education specialists in private industry.

Programs for the doctoral degree in education are planned individually by the students and their guidance committee in the fields of curriculum and instruction, educational administration, and teacher development. Students must also meet specific University, department, and program requirements. Applicants should contact the department for further information on opportunities and requirements.

Admission

Students admitted to the program will normally have completed a master's degree in education or a related field and will have worked full time as an educator at the elementary, secondary, or college level. Entering students are expected to have completed graduate-level coursework in educational psychology, curriculum and instruction, educational structure and change, and the philosophical and social foundations of education. Exceptional candidates who do not meet all these prerequisites will be considered.

To apply, candidates must submit a graduate school application, transcripts of all undergraduate and graduate coursework, and Graduate Record Examination (GRE) general test scores. Candidates must also submit an extended personal statement in addition to the one required on the graduate school application. On-campus interviews are recommended.

Degree Requirements

Candidates for the degree must (1) meet admissions requirements, (2) develop and complete an approved program of study in consultation with their guidance committee, (3) complete required core coursework, (4) pass a qualifying examination to advance to candidacy, (5) establish a dissertation committee, (6) develop an approved dissertation proposal, (7) write and present the dissertation, and (8) pass the final oral examination.

Program of Studies

During the first year of study, students will identify, in consultation with their advisers, faculty to serve as a guidance committee. These members will be appointed by the dean of the Graduate School. A program of study developed by the student and the guidance committee will include common core courses: Proseminar in Doctoral Studies, Normative Inquiry in Education, Methods and Techniques of Educational Research, and Issues and Methods of Ethnographic Research; fo-
cused and specialized coursework in curriculum and instruction, educational administration, or teacher development; integrative coursework across areas of inquiry; and appropriate electives. Typically, students complete 60 hours of graduate credit following their matriculation. Specific course requirements will be established by the guidance committee.

Qualifying Examination Written qualifying examinations are developed by the student's guidance committee in consultation with the coordinator of the Ph.D. in Education and other faculty. Qualifying examinations are administered after a student has completed at least two-thirds of his or her coursework. Following successful completion of the qualifying examination, the student proposes a topic for dissertation research. He or she is then advanced to candidacy, and a doctoral committee is appointed by the dean of the Graduate School.

Dissertation To complete the degree, the student must present and defend a dissertation of original research and publishable quality.

Doctor of Philosophy in Reading and Writing Instruction

Program Information: Jane Hansen

The primary purpose of this Ph.D. program is to prepare students to practice research and successfully publish their results. Within the program and beyond, students study the theory and practice of teaching reading and writing as related processes. Research is usually conducted in natural environments, and study within this program is on a full-time basis. Students' backgrounds vary: some are educators interested in adult education, others concentrate on preschool education. Program graduates work in universities, colleges, and various public or private educational settings.

Admission Requirements Applicants must have at least three years of teaching experience. Although most of our students have a master's degree, it is not required for admission. Applicants must submit a Graduate School application (except for the personal statement); a supplement to the Graduate School application (available from the Writing Lab in the education department); transcripts of all previous coursework; and Graduate Record Examination (GRE) general test scores. We also encourage applicants to come to the University and meet the faculty and students in the department.

Degree Requirements As part of the interdisciplinary program, students will take courses outside of education in English and at least one other University department. The program has one required course, a year-long seminar in reading and writing instruction. With faculty assistance, students design a course of study that will ensure they gain expertise in reading and writing instruction, language development and learning, and processes of conducting research. Once they have completed nearly all of their coursework, students will take a written qualifying examination. Passing this exam advances students to degree candidacy. They then meet with a committee to discuss the proposal for their dissertation. Once the dissertation is complete, they will then defend their work in an oral session. Students can complete the degree in three years, with two years of concentrated coursework and a third for their dissertation.

Administration and Supervision

Program Information: Charles Ashley, Richard Barton, Todd DeMitchell, Virginia Garland

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 (20 credits): CAGS students may select any five of the following six core courses: 962, Educational Finance and Business Management; 964, Personnel and Communication in Educational Organizations; 968, Collective Bargaining in Public Education; 970, The Change Process in Education; 971, School Facilities Management; and 973, Analysis of Educational Policy.

Electives (8 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

Education
The Department of Education offers the degrees of master of arts and master of education. 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.

**Early Childhood Education**

**Program Information:** Bruce L. Mallory, Rebecca S. New

The Department of Education offers the master of education degree in early childhood education and an option in special needs. Certification as an early childhood teacher (K-3) is available. This program is designed for experienced teachers and other early childhood practitioners who wish to improve their professional competence and broaden their career opportunities. The program emphasizes the acquisition of knowledge and competencies in child development (birth through eight years), learning environments, developmentally appropriate curriculum, developmental and cultural diversity, and professional leadership. The coursework culminates in extensive field-based experience.

**Admission Requirements:** All admitted students are expected to have had at least one course in child development at the upper-division level and at least 200 hours of supervised classroom experience with children from birth through eight years of age, or the equivalent.

**Core Requirements (30 credits):** 941, Child Development for the Early Childhood Professional I; 942, Child Development for the Early Childhood Professional II; 943, Environments for Early Childhood Education; 944, Curriculum for Early Childhood Education; 948, Leadership and Advocacy in Early Childhood Education; 949, Supporting Parents of Young Special Needs Children.

**Electives (6 credits):** Selected in consultation with the program adviser.

**Concluding Experience:** A degree candidate must successfully complete one of the following: a comprehensive written and oral examination or a research thesis.

**Early Childhood Education**

**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: teachers of reading, clinicians, and consultants.

The program's requirements are as follows:

**Core Requirements (28 credits):** 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.

**Special Education**

**Program Information:** Georgia Kerns, Bruce Mallory, Jan Nisbet, William Wansart

The special education program prepares highly qualified teachers capable of collaborating with classroom teachers as team teachers or consultants to meet the needs of children and young adults with disabilities in inclusive,
noncategorical public school settings. Graduates will be certified in general special education.

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 from courses in special education, including learning disabilities, mental retardation, emotional handicaps, and supporting parents of special needs children.

Advanced Courses (8 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 complete a major curriculum action research project with a defense or a research thesis. The thesis typically involves an additional 6 to 10 credits.

Teacher Education

Program Information: Michael Andrew, Sharon Nodie Oja, Randall Schroeder

The Department of Education offers the master of arts in teaching degree in elementary and secondary education for those seeking initial teacher licensing and the master of education degree in elementary and secondary education both for those seeking teacher licensure and for experienced teachers.

Applicants to teacher education programs are evaluated on the following criteria: undergraduate academic record, Graduate Record Examination (GRE) general test scores, and letters of recommendation. Those seeking admission to programs leading to teacher licensing should also have a positive recommendation from EDUC 500, Exploring Teaching or equivalent experience.

Any course taken in the Department of Education that will be used to fulfill a teacher licensure 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 Licensure

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 teaching licensure at the elementary and secondary levels.

Licensure requirements that must be met prior to or as part of the master’s degree program include completion of 4 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 licensure 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 licensure receive academic preparation in working with exceptional children, which is integrated throughout licensure coursework. Those pursuing teacher licensure 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).

Credits earned in the seven-week Live, Learn, and Teach summer program may be applied toward the master’s degree. Live, Learn, and Teach satisfies the EDUC 500, Exploring Teaching requirement; 4 credits of EDUC 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.

Preparation for licensure 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 license allows recipients to serve as special education resource room teachers. In order to qualify for licensure 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 (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: 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 licensure: 806, Introduction to Reading Instruction in the Elementary Schools, or 907, Foundations of Reading Instruction; and one appropriate mathematics course). An additional 12 credits outside the Department of Education related to the student’s teaching field are selected to form a concentration. Secondary candidates may apply a methods course taken outside the Department of Education to the 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 (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: Core requirements are identical to those for the master of arts in teaching degree. 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 Experienced Teachers (Elementary and Secondary) The elementary and secondary education programs for experienced teachers are designed to enhance the teaching and leadership skills of the classroom teacher.

The program has the following requirements:

Core Requirements (12 credits): Selected from the following: 885, Educational Tests and Measurements; 903, Normative Inquiry; 953, Seminar in Curriculum Study; 965, Educational Supervision; 986, Philosophy of Education; and 990, Developmental Perspectives on Adulthood.

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) Schoo 1ing 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 four-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 credits required for teacher licensure. Prereq. for teacher licensure 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 licensure: 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 licensure 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 licensure 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 licensure: 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) Social Studies Methods for Middle and High School Teachers; 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 four-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 credits required for teacher licensure. Candidates for teacher licensure should be aware that each licensing area has a specified methods course required for that area, e.g., all elementary education candidates need to complete 803F and 803M; English licensure candidates must complete ENGL 892, Teaching Secondary School English. Contact the Dept. of Education for a complete list of the required methods courses for each licensure area. Prereq. for teacher licensure 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 licensure: permission, as described above. 2 or 4 cr.

805. Alternative Perspectives on the Nature of Education

A) Contemporary Educational Perspectives; B) Controversial and Ethical 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; H) Education as a Form of Social Control; I) Schooling and the Rights of Children; J) 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 four-credit courses offered each semester (listed in department; refer to Time and Room Schedule). Minimum of 4 cr. required for teacher licensure. Prereq. for teacher licensure 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 licensure: 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 licensure 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.

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.

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 is placed on the implications of providing reading instruction in the least restrictive alternative. 4 cr.

885. Educational Tests and Measurement
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 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. 4 cr.

900. 001. 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.

902. Doctoral Proseminar in Education
Introduces students to the range of scholarly inquiry undertaken in doctoral programs. Students develop a broad understanding of educational studies and analyze various research paradigms in terms of assumptions, methods, and outcomes. Coursework includes developing a proposal. Matriculated doctoral students only. 4 cr.

903. Normative Inquiry in Education
A critical study of some of the central normative ideals, concepts, and assumptions that shape contemporary educational policy and practice. The course has two interrelated parts. Part I focuses on an understanding of, and skill in using, the critical perspective embodied in argument analysis and assessment. Part II broadens that perspective in application to normative issues and involves systematic and critical reflection on moral theories, moral experience, and their relevance to education. 4 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
In-depth study of reading processes, theoretical bases, and principles applicable to the teaching of reading (K–12). 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; weekly seminar. 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 coursework 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 teaching of 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 are emphasized 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 on 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. 4 cr.

929. Advanced Counseling Internship
Supervised application of advanced counseling theory and practice in counseling relationships. Sample 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. Lectures, readings, and simulated cases 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 on 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 high 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 devel-
opment; (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
Weekly seminars on current and/or controversial topics related to special education services. Possible topics include service delivery systems, classification and labeling, assessment, instructional techniques, classroom management, consultation, and the special educator as researcher. Prereq: matriculated student or permission. 4 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 I
Focus on typical child development from birth to age eight. Considers theories of child development and assessment from historical and contemporary perspectives, with emphasis on observation during naturally occurring activities as a means of learning about child development. Includes child study. Prereq: permission. 4 cr.

942. Child Development for the Early Childhood Professional II
Considers the growing body of knowledge on the role of play in children's development; includes examination of contemporary constructivist theory. Organized around theme of teacher as researcher. Assignments include research review and student-designed study of child development issue. Prereq: EDUC 941 or permission. 4 cr.

943. Environments for Early Childhood Education
Forum for exchange of knowledge on developmentally appropriate environments for young children. Considers interface between characteristics of the environment (physical and social as well as organizational) and children being served. Includes field visits to settings appropriate for typically developing children as well as those with special needs. Prereq: EDUC 941 or permission. 4 cr.

944. Curriculum for Early Childhood Education
Classroom applications of constructivist theory. Curriculum planning and implementation; overview of research and theory related to teaching and learning of specific content areas, with emphasis on integrated approach to early childhood curriculum. Stresses the reciprocal nature of student-teacher relationship. Prereq: permission. 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.

947. Curriculum for Young Children with Special Needs: Evaluation and Program Design
Overview of evaluation and intervention issues relevant to early childhood special education, focusing on ages three through eight. Norm-referenced and criterion-referenced assessment tools. Judgment-based evaluation and observation skills. Translation of evaluation information into goals and objectives for individual education programs. Developing appropriate programs in inclusive settings. 4 cr.

948. Leadership and Advocacy in Early Childhood Education
Examination of roles and responsibilities of early childhood professionals, with emphasis on action research skills, analysis of contemporary problems, strategies for advocacy, and program leadership skills. 4 cr.

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

950. Culture, Diversity, and Child Development: Implications for Theory and Practice
Study of child development from comparative perspective, considering race, gender, and disabling conditions as dimensions of diversity. Cross-cultural research examined as challenge to contemporary theories of child development. Ethnopsychology of child development. Use of anthropological methods in study of child development. Implications for educational theory and practice. Prereq: permission. 4 cr.

951. Laws and Regulations Affecting the Education of Handicapped Children
Analysis of current federal and state policies affecting handicapped children. Focus is on Public Law 94-142. The role of policy making and constitutional and ethical issues are 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 and trends in policy making, theories in school management, personnel, public relations,
finance, decision making, 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 is part of the project work. Prereq: EDUC 961. 4 cr.

963. Seminar in Educational Administration
Cases and concepts in decision making, motivation, job satisfaction, delegation of responsibilities and definition of duties, planning, power, ethical considerations, minorities, and current 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. Prereq: permission. 4 cr.

968. Collective Bargaining in Public Education
An examination of collective bargaining as practiced by school boards, administrators, and teacher organizations. Consideration is 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 population projections, characteristics of the present and future educational programs, 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 965; 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 experience 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) is given upon successful completion of the internship and field project. 6 cr.

976. The Principalship
Explores the theories and practical realities of the role and function of the public school principal. Reviews in depth leadership in the instructional setting, as a function of culture building, and as a moral craft; and the administration of a school. Students develop a knowledge base about the principalship and apply that knowledge through role playing, in-basket activities, and problem-solving activities. Prereq: two courses in educational administration. 4 cr.

977. The Public School Superintendent
Examines the school superintendent, focusing on the complexity of the current role and relationships, the critical issues facing school leaders, and the skills necessary for success as an educational leader in today's climate. Students analyze contemporary issues of school governance and examine problems of practice to understand the role of school superintendent from a historical, theoretical, political, and contemporary perspective. Prereq: M.Ed.; open to C.A.G.S. and Ph.D. students. 4 cr.

980. Research in the Teaching of Writing
Review of the last thirty 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.

982. Issues and Methods in Ethnographic Research in Education
Provides theoretical grounding and field experience in ethnography as a deliberate inquiry process. Examines the application of ethnographic fieldwork to educational 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. Prereq: permission. 4 cr.

988. Alternative Models of Teacher Development
Examines the historical and current directions in the education of teachers with an emphasis on analysis of alternative models of teachers education. 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.

991. Curriculum Theory
Explores models of curriculum theorizing, the relationship between curriculum theory and society and school practice, and current curriculum issues and reform initiatives. 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.

999. 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; Filson H. Glanz; L. Gordon Kraft; John R. LaCourse; W. Thomas Miller III; Joseph B. Murdoch; John L. Pokoski; Kondagunta Sivaprasad
Adjunct Professors: Sidney W. Darlington; Robert E. Levin
Associate Professors: Michael J. Carter; Kent C. Chamberlin; Allen D. Drake; Donald W. Melvin; Richard A. Messner; Paul J. Nahin; Andrzej Rucinski
Adjunct Associate Professor: Stuart M. Selikowitz

Adjunct Assistant Professor: Benjamin H. Hoffman
Graduate Program Coordinator: Michael J. Carter

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, electrical circuits, with appropriate laboratory experiences. Students with a baccalaureate degree from non-U.S. universities must take and submit general scores from the Graduate Record Examination.

M.S. Degree Requirements
Each student meets with a faculty advisor 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; aperture and cylindrical waveguides; waveguide discontinuities and impedance matching; solid state microwave sources. Prereq: electromagnetics and waves I. 4 cr.

811. Digital Systems
Digital design principles and procedures, including topology and 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.

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.

815. Introduction to VLSI
Principles of VLSI (very large scale integrated) systems at the physical level. CMOS circuit and logic design, CAD tools, CMOS system case studies. Students exercise the whole development cycle of a VLSI chip: design, layout, and testing. Design and layout are performed during semester I. The chips are fabricated off campus, and returned during semester II, when they are tested by the students. An IA grade is given at the end of semester I. Prereq: computer organization. 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 Haugh 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 on 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 discrete 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 electromagnetics and waves. Lab. 4 cr.

861. Optical Engineering
First-order imaging optics, thin and thick lenses, aberrations, mirrors, stops, aper-tures, 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; state feedback; parameter sensitivity; controllability; observability; 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. Prereq: advanced electronics I. (Also offered as OE 881.) Lab. 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. Prereq: human anatomy and physiology or equivalent; advanced electronics. 4 cr.

885. Underwater Acoustics
Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, and mode theory, radiation of sound, transducers, and small- and large-signal considerations. (Also offered as OE 885.) 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. Systems interactions, stability, noise, and the relation of system malfunction to disease. Prereq: human anatomy and physiology or equivalent; 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; waveguides; 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.

#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 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.

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 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 M E 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.

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; permission. 3 cr.

992. Advanced Topics in Electrical Engineering
3 cr.

993. Advanced Topics in Computer Engineering
3 cr.

994. Advanced Topics in Systems Engineering
3 cr.

995. Master’s Project
Independent theoretical and/or experimental work under guidance of a faculty advisor. 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
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: Jean Benoit, area coordinator.
Electrical Engineering: Michael Carter, area coordinator.
Mechanical Engineering: John McHugh, area coordinator.
Systems Design: David E. Limbert, 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 civil and 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 dissertation, 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; Mary Morris Clark; Michael V. DePorte; Karl C. Diller; Walter F. Eggers; Michael K. Ferber; Burt H. Feintuch; Lester A. Fisher; Melody G. Graulich; Elizabeth H. Hageman; Robert Hapgood; Jean E. Kennard; Rochelle Lieber; Andrew H. Merton; Thomas R. Newkirk; Philip L. Nicoloff; Susan Schibanoff; Patrocinio P. Schweickart; Charles D. Simic; Mark R. Smith; David H. Watters; John A. Yount
Associate Professors: Janet E. Aikins; Brigitte Gabcke Bailey; Robert J. Connors; Jane T. Harrigan; Susan Margaret Hertz; Romana C. Huk; Lisa Watt MacFarlane; Mekeel McBride; Sarah Way Sherman; Rachel Trubowitz
Assistant Professors: Elizabeth Jane Bellamy; Margaret-Love G. Denman; John Richard Ernest; Diane P. Freedman; James Krasner; Douglas M. Lanier; John S. Lofty; Lisa C. Miller; Ramachandran Sethuraman; Sandhya Shetty; Patricia A. Sullivan

Graduate Program Coordinator: Rochelle Lieber

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 guidelines available from the English department graduate office. All applicants (except those in M.S. for teachers) are also required to submit Graduate Record Examination scores for the general test. Applicants for the degree of philosophy 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. Nine working writers supervise the program. Students must 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 graduate seminars in this department. The other courses should be at the 800 or 900 level and must include: Practicum in Teaching College Composition (ENGL 910); 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 bibliogra phy 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; and usually, after most coursework has been completed, (2) a qualifying examination with written and oral components testing general knowledge of the field, two major areas of specialization, and one related area. 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.

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 nonfic-
tion, 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.

812. Feminist Criticism Theory and Practice
Focuses on (a) historical development of feminist criticism and the evolution of gender as a literary and critical concern; and (b) the theoretical and practical implications of gender on literary production and reception. Possible texts include classic works by Woolf, De Beauvoir, Rich, and others; works on more recent theoretical trends and developments from other disciplines; and a selection of literary works to be read in conjunction with the criticism and theory. 4 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 influences or determines 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.

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.)

832. Folklore and Folklore
Examines the materials and methods used to study folklore and folklife, emphasizing the historical context and development of folklore studies in North America and Europe, field research, performance theory, and other topics. 4 cr.

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. (Not offered every year.)

846. Special 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. Special 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. Special 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. (Not offered every year.)

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. (Not offered every year.)

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.

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.

855. Chaucer
A study of The Canterbury Tales in its original language. 4 cr. (Not offered every year.)

856. 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.)

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.)

866. English Literature in the 18th Century
Representative works; texts studied closely; the ways they reflect the central intellectual problems of their age. 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. 4 cr. (Not offered every year.)
Voltaire, Sterne, Rousseau, Beckford, Diderot, Godwin, and Blake. 4 cr. (Not offered every year.)

### #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.)

### #872. #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. (Not offered every year.)

### #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. Twenty-first-century authors: Joyce, Yeats, Synge, O’Casey, Beckett, and Flann O’Brien. 4 cr. (Not offered every year.)

### #876. 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.

### #878. 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. (Not offered every year.)

### #881. English Drama from 1660 to 1780
Representative plays, both serious and comic, by such writers as Wycherley, Congreve, Etheredge, Goldsmith, Sheridan, Davenant, Dryden, Otway, Rowe, and Lillo. 4 cr. (Not offered every year.)

### #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.

### #886. Twentieth-Century British Fiction
Traces the development of the novel from the turn of the century to the present day. Representative novels by Lawrence, Joyce, Conrad, Woolf, West, Forster, Huxley, Waugh, Murdoch, Burgess, and Lessing. 4 cr.

### #890. Special Topics in Linguistic Analysis
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. (Not offered every year.)

### #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.

### 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.

### 910. Practicum in Teaching College Composition
Focus on problem issues and methods for teaching writing to first-year students. Open only to teachers in Freshman English program. 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. Because of its special focus, this course may not be applied to the M.A. in English/Writing option. 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, Quintilian), the eighteenth century (Blair and Campbell), and the modern era (Burke, Booth, Perelman, Ong, Weaver). 4 cr.

### 913. Theory and Practice of Composition
Examination of major theoretical and pedagogical works in the field of composition. To include works on the writing process, writing development, response to writing, and other topics. 4 cr.

### 914. Special Topics in Composition and Rhetoric
Topics chosen by instructor may include: A) Political, Philosophical, and Ethical Issues
in Composition; B) Gender and Writing; C) Cognition and Composition; and D) Ethnographics of Literacy. 2-6 cr.

916. History of Composition
Composition teaching and theory in American colleges and academies from the 18th century to the present. 4 cr.

918. Research Methods in Composition
Overview of major research approaches including historical, case study, ethnographic, and textual; special emphasis on research design. 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.

923. Advanced Essay Writing
Writing and reading course in which students are encouraged to experiment with a variety of styles and forms. Discusses outside reading by focusing on techniques that the student might want to apply to their own material. Prereq: permission. 4 cr.

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.

994. Practicum in Teaching English to Speakers of Other Languages
Students 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.

926. Seminar—Literary Theory
4 cr.

927. Seminar—Feminist Criticism Theory and Practice
4 cr.

932. Seminar—Folklore and Folklife
4 cr.

935. Seminar—Studies in American Literature
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.

981. Seminar—Studies in Post-Colonial Literatures in English
4 cr.

990. Seminar—Linguistics
4 cr.

992. Seminar—20th-Century 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. 1-8 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
Professors: James S. Bowman; John F. Burger; R. Marcel Reeves
Associate Professors: Donald S. Chandler; Paul C. Johnson
Adjunct Assistant Professor: Siegfried E. Thewke
Graduate Program Coordinator: John F. Burger

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 lack-
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 ntidity 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 FOR 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, and 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.)

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, cultural, 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: Kristine M. Baber; Elizabeth M. Dolan; Larry J. Hansen; Michael F. Kalinowski; Victor R. Messier
Assistant Professors: Nancy K. File; Barbara R. Frankel; Li-ying Hilary Tso
Graduate Program Coordinator: Elizabeth M. Dolan

Degree Offered
The Department of Family Studies offers two programs of study leading to a master of science degree in family and consumer studies. The thesis program is designed to develop general competence in understanding and applying theory and research regarding child, family, and consumer issues. The marriage and family therapy option is a clinical program that prepares students to work with families in a clinical setting. The goal of both programs 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 clinical program requires a minimum of two years of full-time study, including two summers. Alternative plans of study may be possible.

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 personal interviews are required of applicants for the marriage and family therapy option. Information can be obtained by contacting the department's graduate coordinator.

M.S. Degree Requirements

Each student will complete coursework appropriate to his/her area of specialization. In the thesis program, requirements include (1) completion of the 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 include (1) the 12-credit core curriculum (described above); (2) 28 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 Prob-
lems 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 and presentation. 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. Prereq: Family; 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. Prereq: one course in economics or permission. 1–6 cr.

809. Child Study and Development Center Internship
Supervised positions within the UNH Child Study and Development Center child care programs. Prereq: one course in economics or permission. 1–6 cr.

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: FS 833; permission. 4 cr. (Spring 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.

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.

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. Prereq: one course in economics or permission. 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.

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. Professional Issues for Family Specialists
Preparation for professional roles related to the helping professions; evaluation and assessment 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.

945. Family Therapy Practice I
Designed to develop beginning practice skills in structural, strategic, systematic family therapies; and assessment and treatment skills necessary to manage specialized problems (e.g., divorce, remarriage, substance abuse, suicidal behavior) encountered in practice. Prereq: permission. 4 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 advanced skills in integrating structural, strategic, and systematic family therapies; sensitivity to gender differences and cultural diversity; and assessment and treatment skills necessary to manage specialized problems (e.g., physical, emotional, and sexual abuse; sexual dysfunction) encountered in practice. Prereq: permission. 4 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 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.
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.

Genetics Program (GEN)

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

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, natural 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 three 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.; biochem. (Also offered as MCR 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 BIOL 805.) 4 cr. (Not offered every year)

815. Molecular Evolution
Molecular mechanisms of organizational evolution. Emphasis is on integrating evidence from biochemistry, molecular genetics, developmental biology, and organismal studies. Review of population genetics and the neutral theory. Evolution of sex. Genetics of speciation. Methods of reconstructing phylogeny from molecular sequences. Prereq: genetics or permission; some knowledge of statistics plus a computer language (BASIC or PASCAL) is recommended. (Also offered as ZOOL 815.) 4 cr.

822. Immunogenetics
Cellular interactions and immune regulatory mechanisms. Genetics of the major histocompatibility complex, antibody diversity, and immune responses. (Also offered as ANSC 822.) 4 cr. (Offered alternate years.)

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 BIBIO 840.) 4 cr. (Not offered every year)

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. (Also offered as BIBIO 853.) 4 cr. (Not offered every year)

871. Molecular Genetics
Structure, organization, replication, dynamics, and expression of genetic information in eukaryotes. Focus on molecular genetic mechanisms of gene expression and its control; molecular genetics methods; molecular genetic control of cell division and differentiation during development. Prereq: general biochemistry or 851; principles of genetics/or permission. (Also offered as BICHM 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: BICHM 852; BICHM 871 or MCR 804. (Also offered as BICHM 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 BIBIO 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 BIBIO 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

Family & Consumer Studies, Genetics

75
factors, treatment, selection (particularly when several factors are suspected of having an influence on response), and computer-aided analysis of results. Prereq: statistics. 3 cr. (Not offered every year.)

904. Advanced Microbial Genetics
Advanced studies in expression, 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.

Natural Resources
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.

Forestry
820. Forest Genetics
Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characteristics, quantitative data analysis. Prereq: prin. of genetics; silviculture; or permission. Special fee. Lab. 3 cr. (Not offered every year.)

Plant Biology
873. Breeding Improved Varieties
Techniques for creating new varieties of crop and ornamental plants. Discussion and assigned readings in crop breeding. Prereq: genetics. 4 cr.

Health Administration (HMP)
Chairperson:

David A. Pearson

Professors:
David A. Pearson; Roger A. Ritvo; John W. Seavey; Lee F. Seidel

Associate Professors:
Robin D. Gorsky; Marc D. Hiller; Jeffrey Colman Salloway

Assistant Professor:
James B. Lewis

Graduate Program Coordinator:
David A. Pearson

Degree Offered
The Department of Health Management and Policy offers a program leading to the master of health administration (M.H.A.), the professional degree of the field, in a format designed for the experienced and practicing individual in health management and policy. The objective of the program is to enable students to improve their effectiveness and performance in the management of health care organizations, services, programs, and policies.

Admissions Requirements
The department is pleased to review for admission individuals who: (1) have a baccalaureate degree from an accredited college or university; (2) submit scores from either the Graduate Management Admissions Test (GMAT) or the general test of the Graduate Record Examination (GRE); (3) have successfully completed undergraduate courses from an accredited college or university in each of the following areas: financial accounting, statistics; (4) have satisfactory health-related professional experience (minimum of two years); and (5) have acceptable recommendations from three individuals, one of whom must be a member of an academic faculty and another must be experienced in the field of health management and policy. Applicants are expected to have experience in the use of computers (Minitab; Lotus 1-2-3; WordPerfect).

M.H.A. Degree Requirements
Directed primarily at the employed professional, the M.H.A. curriculum consists of a coordinated and sequenced grouping of twenty courses normally completed over twenty-two months of study involving two weekends per month (Friday/Saturday) from September through late May, plus two one-week residential periods—one in late August, the other in late May. Competencies from the functional areas of management (accounting, finance, human resources management, marketing) are linked with skill courses involving the planning, administration, and evaluation of health and medical care services. Satisfactory completion of a field study experience (praxis) is also required.

810. Financial Management for Clinicians
Includes basic elements of health care financial management and cost accounting, including cost concepts and product costing, budgeting, and variance analysis with an emphasis on the departmental level of health care organizations. Contains an overview of basic principles of accounting, focusing on the balance sheet and statement of revenues and expenses to include their analysis using the tools of ratio analysis. Concludes with the basic concepts of capital project analysis and health care reimbursement. Prereq: enrollment in nursing master's program; HMP majors not allowed. 3 cr.

900. Health Care in the United States
Identification and examination of elements that comprise the health care system in the United States. Analysis of interaction between health organizations with political, economic, and other social systems. 3 cr.

901. Health Economics
Application of economic concepts and principles to the study of health services; emphasis on the financing and delivery of personal medical care systems. 3 cr.
903. Health Care Planning
Theoretical and historical foundations of health planning; the relationship of health planning and regulation; application of planning methods; and use of strategic planning and its relationship to marketing. Prereq: permission. 3 cr.

904. Health Policy
Analyzes the public policy process and development of health policies in the United States, and discusses specific health policy issues. 3 cr.

905. Long-Term Care Policy
Seminar on public policy including home-based, community-based, and institutionally-based services; selected federal and regional policy issues in planning for and responding to the needs of an aging population. 3 cr.

906. Comparative Health Care Systems
Analyzes and compares world health problems and delivery systems using nations with different cultures, political and economic systems, and stages of economic development. Methods for developing and evaluating health care systems. 3 cr.

907. Managed Health Care
Discusses the historical antecedents of managed health care and explores current techniques directed at controlling health care costs. 3 cr.

908. Health Care Quality Assurance and Assessment
Historical antecedents of quality measurement and assurance programs. Describes and evaluates current approaches to assessing and improving the quality and management of health care including application of total quality management. 3 cr.

910. Epidemiology
Distribution and determinants of disease, illness, and health in the community. Community health and illness measures, status, and data. Applications to health services management. 3 cr.

911. Statistics in Health Care Management
Application to health administration and policy of statistical tools. Includes frequency distributions, measures of central tendency, measures of variability, and probability plus linear correlation, regression, analysis of variance, and other statistics. 3 cr.

912. Quantitative Methods in Health Care Management
Applications of statistical methods, operations research, and quantitative management sciences within health management and policy contexts. 3 cr.

920. Organization Theory in Health Care
Applies organization theory and behavior to health organizations. Motivation and leadership, work group dynamics, communications, and negotiations within the health care organization as an open system; concentrates on topics involving organizational design, change, and innovation. 3 cr.

921. Managing Health Services
The role and function of the manager, governance, and the management of operations in health care organizations. Determinants of management strategy and action. 3 cr.

923. Health Services Marketing
Theories and practices of marketing and marketing research. Marketing strategies and outcomes examined from the perspective of the health care organization and professional. 3 cr.

924. Human Resources Management in Health Care
Role of human resources management in meeting goals in health care organizations, functions of human resources management, organization of personnel activities and staff, relationship of managers to personnel administration staff and activities. 3 cr.

925. Ambulatory Care Management
Synthesis and integration of the subject and application of theory to actual situations through the use of case studies that raise management issues and problems in a wide variety of ambulatory care settings. 3 cr.

926. Health Care Management Information Systems
Concepts and implementation of information systems to support managerial planning, control, and decision making. Process for information system analysis, design, and implementation. 3 cr.

927. Management of Mental Health Services
Synthesis and integration of the subject and application of theory to actual mental health administration situations through the use of case studies. 3 cr.

928. Long-Term Care Management
Using case studies, describes situations and problems faced by long-term care managers; synthesis and integration of the subject matter and application of theory to actual long-term care management situations. 3 cr.

929. Hospital Management
Synthesis and integration of the subject matter and application of theory to actual hospital management situations through the use of case studies. 3 cr.

930. Managerial Accounting for Health Care Organizations
Cost accounting, cost analysis, and budgeting in planning and controlling health services. Techniques of variance analysis, cost allocation, ratio analysis, and management of working capital, rate setting, and reimbursement. 3 cr.

931. Health Care Finance
Capital investment decision analysis, sources, and uses of capital to finance health care organizations. Theories of finance related to the management of health organizations. 3 cr.

932. Health Care Reimbursement
Analyzes and discusses payment techniques used by third-party payers to pay for services rendered to insured or program beneficiaries by health care organizations and individual providers. 3 cr.

940. Legal Strategies in Health Care
Legal issues that affect the management of health care organizations. Topics include corporate liability, anti-trust, contract law, tort issues, and labor law. 3 cr.

950. Ethics and Health Care
Professional and ethical issues confronting health services administrators. Case studies apply different models of ethical decision making. Analyzes competing organizational and professional interests, values, and responsibilities. 3 cr.

960. Advanced Topics in Health Management and Policy
Discussion of current topics in selected areas of health management and policy. 1-3 cr.

975. The Praxis
An applied experience consisting of field study and the development of management or policy case studies and supporting analysis to explore the relationship between theory and professional practice. 1-3 cr.

995. Independent Study
Directed readings and other activities to explore a specific topic related to health management and policy. Prereq: permission. 1-3 credits.

998. Strategic Management of Health Care
Examines the operations of health service organizations through the role of the manager. Uses case studies and other techniques to integrate content covered in previous courses. 3 cr.
History (HIST)

Chairperson: Jeffry M. Diefendorf
Professors: Charles E. Clark; Jeffry M. Diefendorf; William R. Jones; Francis D. McCann, Jr.; Robert M. Mennel; Harvard Sitkoff; Laurel T. Ulrich; John O. Voll; Douglas L. Wheeler
Associate Professors: J. William Harris, Jr.; Allen B. Linden; Gregory McMahon; Janet L. Polasky; Marc L. Schwartz
Adjunct Associate Professor: William R. Woodward
Assistant Professors: W. Jeffrey Bolster; Cathy A. Frierson; Kristin E. Gager; Jan V. Golinski; Eliga H. Gould; Lucy E. Salyer
Graduate Program Coordinator: J. William Harris, Jr.

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 on the history of the United States or on topics comparing the United States with other societies or areas.

Admission Requirements

The department usually requires evidence of substantial preparation in history at the undergraduate level, together with some preparation in other areas of 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 from 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 may be 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 include the following: the ancient world, medieval Europe, early modern Europe, modern Europe, European intellectual history, medieval England, early modern England, modern England, early modern France, modern France, early modern Germany, modern Germany, Iberia, Russia, early U.S., modern U.S., 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 U.S. history and one in modern U.S. 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) preparation through reading and coursework in the entirety of U.S. history, with accent upon either early or modern U.S.; 6) preparation through reading and coursework of two subfields outside of U.S. history, one of which may be a cognate field outside of history entirely; 7) qualifying exams; 8) dissertation and successful defense.

Note: In the definition of fields above, "United States" and "U.S." is understood to mean the United States and its colonial antecedents.

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 requirement.

#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 communities.
cultures (French, Dutch, Portuguese, and Spanish), with native Americans, and with African and Afro-American slaves. 4 cr.

805. Revolutionary America, 1750—1788
Examines the social, political, and cultural transformation of thirteen British colonies into the United States, up to the adoption of the Constitution. 4 cr.

806. History of the Early Republic
Explores in the histories of people and institutions that transformed the new United States from a coastal republic of largely independent freeholders to a transcontinental democracy increasingly riven by class. Topics include slavery, the family, reform movements, and the formulation of national identity. 4 cr.

#809. U.S. Legal History Special Topics
In-depth thematic exploration of the role of law in American life. Topics include Race and Equality in American Law; Community, Pluralism, and American Law; Property, Liberty, and Law; Gender and Law. May be repeated for credit with instructor's permission. Consult department listing for topics. 4 cr.

811. Civil War and Reconstruction in the United States
A survey of the period from the presidency of Andrew Jackson to the end of the Reconstruction, focusing on the causes, course, and consequences of the Civil War. Topics include slavery in the Old South, antebellum reform movements, creation and breakdown of the Second Party System, social and economic (as well as military) events during the war, and major developments during Reconstruction after the war. 4 cr.

812. The Emergence of Industrial America
Investigates the economic transformation of 19th-century America from a rural, agricultural to an urban, industrial society. Explores the sweeping economic changes, focusing on such topics as changes in work and leisure, westward expansion and its effects on native Americans, shifts in gender roles, growth of a consumer culture, rise of labor unions and populism, immigration, movements for reform and regulation, growth of American imperialism, and intellectual developments. 4 cr.

815, 816. 20th-Century United States
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

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 U.S. 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.

850. History of European Socialism
History of socialist thought and movements in Europe in the 19th and 20th centuries. Examines Utopian Socialism, development of Marxism, emergence of the New Left, and new socialist developments in the late 20th century. 4 cr.

851, 852. Topics in European Intellectual History
Explores major developments such as the Enlightenment, Russian intellectual history, ancient world views and cosmologies, and the relationship between gender and intellectual history. 851 includes topics up to the Scientific Revolution; 852 includes topics since the Renaissance. Because topics vary, students should check the department newsletter or office for course theme in any given term. May be repeated for credit as topics change. 4 cr.

854. Topics in History of Science
Study of a selected topic in the history of European science since the Renaissance. 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.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>861, 862. England in the Tudor and Stuart Periods</td>
<td>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.</td>
</tr>
<tr>
<td>863. Russia: Origins to 1905</td>
<td>Russia from its foundation through the revolution of 1905. Political, social, and economic developments; intellectual and ideological currents. 4 cr.</td>
</tr>
<tr>
<td>864. Russia: Modernization through Soviet Empire</td>
<td>The challenges of modernization; experience and legacy of Leninist and Stalinist revolutions; Soviet consolidation and decline through the Gorbachev era. 4 cr.</td>
</tr>
<tr>
<td>865. Themes in Women's History</td>
<td>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.</td>
</tr>
<tr>
<td>866. Modern Germany since 1848</td>
<td>Advanced study of early modern Germany. Bismarck and Imperial Germany; Weimar and the rise of Hitler; divided Germany after World War II. 4 cr.</td>
</tr>
<tr>
<td>867. Early Modern Germany: Reformation to the Revolution of 1848</td>
<td>Advanced study of early modern Germany. Conflict between Holy Roman Empire and petty states; rise of Prussia; religious conflict and Enlightenment. 4 cr.</td>
</tr>
<tr>
<td>868. Modern Germany since 1848</td>
<td>Advanced study of early modern Germany. Bismarck and Imperial Germany; Weimar and the rise of Hitler; divided Germany after World War II. 4 cr.</td>
</tr>
<tr>
<td>871. Studies in Regional Material Culture</td>
<td>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.</td>
</tr>
<tr>
<td>872. Historiography</td>
<td>Analysis of ancient and modern historians. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)</td>
</tr>
<tr>
<td>875. Historical Methods</td>
<td>Introduction to contemporary historical methods. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)</td>
</tr>
<tr>
<td>876. The Ancient Greek World</td>
<td>Greek history from the Mycenaean period in the Homeric epics through the classical period, the Persian and Polopennesian wars, and the Hellenistic period. Emphasis on original sources including Homer, Herodotus, Thucydides, and Greek playwrights. Special attention to an analysis of the contrast between Spartan and Athenian political systems, the arts in Athens, and the effects of the development of the Athenian thalassicocracy. 4 cr.</td>
</tr>
<tr>
<td>877. The Roman Republic</td>
<td>Covers pre-Roman Italy, the Etruscans, and the foundation of the Republic. Rome's expansion through the Punic Wars, and relations with the Hellenistic kingdoms. Disintegration and final collapse of the Republic. Includes discussion of Roman art, engineering, and political theory. Emphasis on Latin sources in philosophy, history, and literature. 4 cr.</td>
</tr>
<tr>
<td>878. The Roman Empire</td>
<td>Collapse of the Roman Republic and creation of the Augustan principate. History of the principate through the division of the empire, with discussion of the fall of Rome in the west, and the eastern empire through Justinian. Discussion of Roman art, literature, philosophy, religious developments such as the proliferation of mystery religions and the rise of Christianity. 4 cr.</td>
</tr>
<tr>
<td>881. Topics in the History of Modern China</td>
<td>Advanced study of issues in modern Chinese history, 1800 to present. 4 cr.</td>
</tr>
<tr>
<td>882. Religion in World History</td>
<td>Advanced study in the religious experience of man from the perspective of world history. The major modes of religion: development of the major religions traditions and institutions. 4 cr.</td>
</tr>
<tr>
<td>884. History of Southern Africa since 1820</td>
<td>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.</td>
</tr>
<tr>
<td>885. The Modern Middle East</td>
<td>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 appearances of new ideologies. 4 cr.</td>
</tr>
<tr>
<td>887. Quantitative Methods and Computers for Historians</td>
<td>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.</td>
</tr>
<tr>
<td>892. Seminar in the History of Science</td>
<td>In-depth examination of a selected topic in the history of science. Subject varies. No special background in science required. 4 cr.</td>
</tr>
<tr>
<td>936. Reading in Early American History</td>
<td>Introduces the chief themes and issues in the secondary literature of early American history from European settlement through the Early Republic. Team-taught discussion format. Students write a series of short analytical papers. Expected of all graduate students preparing a field in Early America. 3 cr.</td>
</tr>
<tr>
<td>940. Reading in Modern American History</td>
<td>An introduction to major historians and historiographical issues in the history of the U.S. since 1820. Intended to serve as a foundation for research in the field and as preparation for graduate examinations. 3 cr.</td>
</tr>
<tr>
<td>949. Colloquium in U.S. History</td>
<td>Topics include 1) Early American Society; 2) Early American Culture; 3) Revolutionary Period; 4) 19th Century; 5) 20th Century. Focuses on existing scholarly historical literature on a given topic, such as American slavery. Students normally read extensively, discuss major issues and the literature in class meetings, and write essays that examine the literature critically. 3 cr.</td>
</tr>
<tr>
<td>951. Colloquium in European History</td>
<td>Topics include 1) Medieval, 2) Early Modern, and 3) Modern. The course focuses on the existing historical literature on a given topic, such as American history. Students normally read extensively, discuss major issues and the literature in class meetings, and write essays that examine the literature critically. May be repeated if a different topic is selected. 3 cr.</td>
</tr>
<tr>
<td>952. Colloquium in Comparative History</td>
<td>Intensive reading in comparative studies of U.S. history. Compares the experience of the United States and that of some other area or nation. For example, comparing legal history of Britain and the U.S.; the impact of colonization on native peoples in North and South America; the nature of slavery in the U.S., the Caribbean, and Brazil; or the experience of women in Europe and America. Topics vary and the course may be repeated with permission. 3 cr.</td>
</tr>
</tbody>
</table>
983. Colloquium in African, Asian, Latin American History
Topics include 1) African; 2) Asian; 3) Latin American; 4) Middle Eastern. Focuses on the existing scholarly historical literature on a given topic, such as American slavery. Students normally read extensively, discuss major issues and the literature in class meetings, and write essays that examine the literature critically. 3 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. Research Seminar in American History
1) Early American Society; 2) Early American Culture; 3) Revolutionary Period; 4) 19th Century; 5) 20th Century. Focuses on original research on a given topic using primary materials supplemented by secondary works. The objective is to produce a major research paper that might serve as the basis for a publishable article. May be repeated with a different topic. 3 cr.

991. Research Seminar in European History
1) Medieval; 2) Early Modern; 3) Modern. Focuses on original research on a given topic using primary materials supplemented by secondary works. The objective is to produce a major research paper that might serve as the basis for a publishable article. May be repeated with a different topic. 3 cr.

992. Research Seminar in Comparative History
Comparative studies of U.S. history, emphasizing primary research. Colloquium compares the experience of the United States and that of some other area or nation. For example, comparing the legal histories of Britain and the U.S.; the impact of colonization on native peoples in North and South America; the nature of slavery in the U.S., the Caribbean, and Brazil, or the experiences of women in Europe and America. Topics vary, and the course may be repeated for credit. 3 cr.

993, 994. Research Seminar in African, Asian, Latin American History
1) African; 2) Asian; 3) Latin American; 4) Middle East. Focuses on original research on a given topic using primary materials supplemented by secondary works. The objective is to produce a major research paper that might serve as the basis for a publishable article. May be repeated with a different topic. 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.

999. Doctoral Research

Hydrology
(See Earth Sciences.)

Master's Continuing Enrollment (MCE)
990. Master's Continuing Enrollment
Master's students who have completed all course requirements, 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: Kenneth I. Appel
Professors: Homer F. Bechtell, Jr.; Albert B. Bennett, Jr.; David M. Burton; Arthur H. Copeland, Jr.; Marie A. Gaudard; Donald W. Hadwin; A. Robb Jacoby; Loren D. Meeker; Eric A. Nordgren; Samuel D. Shore; Donovan H. Van Osdol
Adjunct Professor: Fernand J. Prevost
Associate Professors: William E. Bonnice; David V. Feldman; Joan Ferrini-Mundy; William E. Geeslin; Karen J. Graham; Edward K. Hinson; Ernst Linder; Berrien Moore; Siu-Keung Tse; Lee L. Zia
Assistant Professors: Daniel E. Bentit; Rita A. Hibschweiler
Graduate Program Coordinator: Samuel D. Shore

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 the four languages (excluding the student's native language): English, 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 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.

A maximum of four of the following courses may be applied to the degree of master of science in mathematics.

835. Probability
Probability measures; random variables; important distributions; moment-generating functions; multivariate distributions; functions of random variables; limit theorems. Prereq: multidim. calculus. 3 cr.

836. Statistics
Parameter estimation, confidence intervals, minimum-variance unbiased estimation, hypothesis testing, likelihood ratio tests, topics from statistical methods. Prereq: MATH 835 or probability and statistics for applications and multidimensional calculus and permission. 3 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. 3 cr.

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. 3 cr.

842. Applied Statistical Methods
Topics chosen from multivariate methods, nonparametric methods, categorical data analysis, sampling theory, decision theory, reliability, statistical process control, and applications to biostatistics or industry. Emphasis on data analysis. Prereq: MATH 835-836 or probability and statistics for applications. 3 cr.

844. Applied Data Analysis
Linear regression, factorial experiments, randomized block designs, factor analysis, canonical analysis, multivariate analysis of variance, and discriminant analysis. (No credit if credit received for MATH 839 or 840.) 3 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, 3 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.) 3 cr.

854. Numerical Methods and Computers II
Mathematical software. Computer solutions of differential equations, eigenvalues, and eigenvectors. Prereq: diff. equations with linear algebra; intro. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as CS 854.) 3 cr.

861. Abstract Algebra
Basic properties of groups, rings, fields, and their homomorphisms. 3 cr.

862. Linear Algebra

864. Advanced Algebra
Topics to be selected from among rings, modules, algebraic fields, and group theory. Prereq: MATH 861. 3 cr. (Not offered every year.)

867. One-Dimensional Real Analysis
Theory of limits, continuity, differentiability, integrability. 3 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. 3 cr. (Not offered every year.)

876. Logic
Induction and recursion; sentential logic; first-order logic; completeness, consistency, and decidability; recursive function. 3 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. 3 cr. (Not offered every year.)

884. Topology
Open sets, closure, base, and continuous functions. Connectedness, compactness, separation axioms, and metrizability. 3 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. 3 cr.

896. Topics in Mathematics
New or specialized courses not covered in regular course offerings. Prereq: permission. May be repeated to 8 credits. 3 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, Lebesgue 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: Kenneth C. Baldwin
Professors: David E. Limbert; Godfrey H. Savage
Associate Professors: Kenneth C. Baldwin; Barbaros Celikkol; Barry K. Fussell; Todd Stuart Gross; Robert Jerard; James E. Krzanowski; John Philip McHugh; William Mosberg; M. Robinson Swift; David W. Watt; John A. Wilson
Graduate Program Coordinator: John Philip McHugh

Degree Offered
The Department of Mechanical Engineering offers the master of science degree. The program leading to the doctorate in engineering is described in the section entitled Engineering Ph.D. Program.

The department offers studies leading to specialization in the following areas: fluid mechanics, thermal science, solid mechanics, material science, controls, system modeling, dynamics, and design.

Admission Requirements
In general, applicants have a bachelor of science degree in mechanical engineering. Outstanding candidates with a bachelor's degree in the other engineering and science disciplines and math are encouraged to apply. Special curricula are developed for such students to provide sufficient background in mechanical engineering.

All applicants are required to submit scores from the general test of the Graduate Record Examination.

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, postualational 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. 3 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.

811. Coherent Optical Methods
Introduction to electro-optic experimental techniques in mechanics. Optic fundamentals including elements of scalar diffraction theory, interferometry, holography, Doppler shifts, coherence, and laser speckle. Applications include mechanical strain measurements, vibrational mode determination, fluid pressure and temperature measurements, and fluid velocity measurements. Concepts from course are demonstrated in laboratory. Prereq: permission. 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
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.

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.

831. Fracture and Fatigue of Engineering Materials
Reviews fundamentals of linear elastic fracture mechanics and strain energy release rate analyses. Discusses basic methods of design and fatigue for preventing failure by fast fracture and fatigue for metals, ceramics, and polymers with attention to the effect of material properties and subsequent modification on each design method. 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, environmentally factors, hydromechanics 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
Introduction to advanced control system design concepts such as Nyquist analysis; lead-lag compensation; state feedback; parameter sensitivity; controllability; observability; 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 database 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.

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.

883. Geometric Modeling
Includes curves, surfaces, solids, analytic and relational properties, intersections, transformations, and solid modeling. Applications in computer graphics and CAD/CAM systems are emphasized. Familiarity with calculus, analytic geometry, vectors, matrix methods, and computer programming is required. Prereq: permission. 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. 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.

909. Viscous Flow
Exact solutions of the Navier-Stokes equations; laminar boundary layers; wakes and jets; Stokes flow; stability of parallel flows and boundary layers; transition to turbulence. Prereq: ME 807 or permission. 3 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 hydrodynamic influences; instability of parallel viscous flows, including the Orr-Sommerfeld equation and Tollmien-Schlichting waves; instability of free-surface waves; instability of stratified flows; instabilities in porous media. Prereq: ME 807 or permission. 3 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; 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; 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.

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; Lyapunov observability. 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 systems, 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 estimation, 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. 4 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, control system design, 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: Richard P. Blakemore
Professors: Richard P. Blakemore; William R. Chesbro; Thomas G. Pistole; Frank G. Rodgers; Robert M. Zsigray
Assistant Professor: Aaron B. Margolin
Graduate Program Coordinator: Robert M. Zsigray

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, Yersinia genetics, microbial immunity, molecular mechanisms of pathogenesis, environ-
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 seminar 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.

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 to 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 are 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.; biochem. (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. 5 cr.

806. Virology


807. Marine Microbiology

Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sampling, enumeration, distribution, and effects of marine environment on microbial populations. Prereq: gen. micro.; organic chem. Special fee. Lab. 4 cr.

809. Advanced Virology

Provides in-depth study of virology. Selected RNA, DNA, retroviruses, and nonretroviruses capable of causing cancer. Enables students to (1) understand genetic regulatory events occurring during virus-cell interactions, and to (2) understand the specific pathogenicity, epidemiology, prevention, and control of selected (model) viruses. Lab. Special fee. Prereq: virology; permission. 4 cr. (Not offered every year.)

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, and with virus ultrastructure. Project work. Prereq: gen. micro.; permission. Special fee. Lab. 5 cr.

813. Microbes and the Environment

Principles of microbial ecology in relation to human ecology. Microbial characteristics influencing their ecological roles. Physiological ecology as required to understand microbes in the flow of energy and matter through ecosystems. Habitats in which microbes have influence; plants and animals as hosts (syntrophic and consortial mixtures, stable symbioses); aquatic (including benthic sediments, vents, and seeps); and terrestrial (soils, cryptoagamic) environments. Environmental signaling and behavioral or metabolic responses by independent cells and social microbes. Methods of evaluating microbial community composition and structure and of measuring microbial numbers, biomass and activity: nucleic acid probes, microelectrodes, radioisotopes and stable isotopes in environmental studies. Enrichment, isolation, and consideration of particular microbial groups important in the biogeochemistry of major elements and metals. Microbes in the context of human activities including waste treatment, design of biodegradable materials, biominning, release of radiatively important trace gases, and bioremediation. Prereq: general microbiology; general biochemistry or cell culture. 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. Special fee. Lab. Prereq: gen. micro. 4 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 the 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.

889. **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; Robert W. Eshbach; Stanley D. Hettinger; Cleveland L. Howard; Christopher Kies; Nicholas N. Oroovich; W. Niel Sir; Kathleen Wilson Spillane; Robert Stibler; Peggy A. Vagts; Larry J. Veal; Paul F. Verrette; Henry J. Wing, Jr.
Assistant Professors: Mark S. DeTurk; Peter W. Urquhart
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.

**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 satisfaction of 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, 959, 990, 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 955 and 994. 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**

801. **Music of the Medieval Period**
NATURE of the beginnings of polyphony. The preeminent influence of the church in the 13th century and the rising secular movement in the 14th. Music as a dominant force in the political and social life of the Middle Ages. 3 cr.

803. **Music of the Renaissance**
Works of the 15th- and 16th-century composers from Dunstable to Palestrina. 3 cr.

805. **Music of the Baroque**
Music of Europe from de Rore to Bach. 3 cr.

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

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. 3 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 in the spring.)

985. 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.

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
Special fee.

842. Graduate Piano
Special fee.

843. Graduate Harpsichord
Special fee.

844. Graduate Organ
Special fee.

845. Graduate Violin, Viola
Special fee.

846. Graduate Violoncello, String Bass
Special fee.

847. Graduate Woodwind
Special fee.

848. Graduate Bass
Special fee.
849. Graduate Percussion
Special fee.
850. Graduate Harp
Special fee.
851. Graduate Early Wind Instruments
Special fee.
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 performance. 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.

890. Teaching Elementary School Music
Experiential approach toward learning creative strategies for teaching elementary school music. Includes various curricula and methods; philosophy and psychology of music; demonstration of materials and instruments. Observation and teaching in schools. 3 cr.
891. Teaching Secondary School Music
Assembling, managing, and teaching the junior/senior high school music curriculum. Academic issues of philosophy, curriculum building, application of learning theories, administration, evaluation, motivation, and classroom management combined with field experience in lesson planning and teaching/rehearsal techniques. Prereq: piano proficiency; conducting methods. 3 cr.

892. Seminar in Music Teaching
Group discussion and demonstration of effective music teaching. On-site examination of school music teaching. Organization and teaching of curriculum units. Normally taken during student teaching semester. 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.
896. 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.

Natural Resources (NR)
Chairperson: William W. Mautz
Professors: John D. Aber; James P. Barrett; John E. Carroll; Robert A. Croker; Nicolas Engalichev; Robert D. Harter; William W. Mautz; David P. Olson; R. Marcel Reeves
Adjunct Professors: C. Anthony Federer; Peter W. Garrett; James W. Hornbeck; William B. Leak; Sidney A. L. Pilgrim
Associate Professors: William B. Bowden; Robert T. Eckert; Christine V. Evans; Theodore E. Howard; John A. Litvaitis; William H. McDowell; Peter J. Pekins; Barrett N. Rock; Richard R. Weyrick
Research Associate Professors: Stephen H. Jones; Frederick T. Short
Assistant Professors: Mimi L. Becker; Russell G. Congalton
Graduate Program Coordinator: Robert D. Harter

Degrees Offered
The Department of Natural Resources offers a master of science in natural resources with options in five areas.

Forestry: forest resource economics and management, biometrics, genetics, wood science and technology, forest ecosystem dynamics, and remote sensing.

Environmental conservation: natural resource policy, conservation biology, sustainability, ecological ethics and values, and international environmental affairs.

Soil science: soil chemistry, soil classification and genesis, forest soils, and soil microbiology.

Water resources: wetlands, land-water interactions, groundwater chemistry, and biogeochemistry.

Wildlife: habitat evaluation and management, wildlife energetics, and population dynamics.

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 option may elect to develop concentrations within any of the above-listed areas. Applicants are expected to have backgrounds in forestry or related biological sciences. Entering students in soil science and water resources are required to have adequate preparation in chemistry and mathematics as well as biological or earth sciences. Students interested in wildlife are expected to have adequate preparation in biological sciences, chemistry, and mathematics. Students interested in environmental conservation should have a background appropriate for their area of interest. Since environmental conservation covers such a broad area, applicants are always reviewed carefully on an individual basis.

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: NR 993, Seminar, 1 cr.; NR 903, Approach to Research, 2 cr.; a quantitative methods course; NR 996, Natural Resource Education, 1 cr.; (2) NR 998, Directed Research, 4–6 cr. or NR 899, Thesis, 6–10 cr.; and (3) a final oral and/or written examination.

Cooperative Doctoral Programs
The Department of Natural Resources participates in three doctoral degree programs in cooperation with other departments in the University. The departmental faculty are an integral part of the interdisciplinary natural resources Ph.D. program (see page 90) and opportunities for doctoral studies under all Department of Natural Resources faculty members are available through this program. In addition, a Ph.D. program in genetics (see page 75) is available to students in forestry through the genetics program, and a Ph.D. in environmental chemistry (see page 42) is available to soil science and water resources students through the chemistry department. Natural resource students specializing in forest ecosystem dynamics may conduct research through the Institute for the Study of Earth, Oceans, and Space.

Courses in Natural Resources (NR)
802. Special Subjects in Natural Resources
Short-term courses (generally a few days to two weeks) offered off campus by the Audubon Society and Appalachian Mountain Club in conjunction with the Department of Natural Resources. Topics vary from year to year. 1–4 cr.

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.)

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. 2 cr.

857. Photo Interpretation and Photogrammetry
Practical and conceptual presentation of techniques for using remote sensing, specifically aerial photographs, in natural resources. Includes photo measures of scale, area, parallax and object heights; flight planning; photo geometry; an introduction to the electromagnetic spectrum; and photo interpretation and mapping. Concludes with an introduction to digital remote sensing including multispectral scanners, radar, and thermal imagery and a brief discussion of geographic information systems (GIS). Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Prereq: algebra. Special fee. Lab. 4 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: NR 857 or equivalent; binocular vision an advantage. Special fee. Lab. 2 cr.

859. Digital Image Processing for Natural Resources
Introduction to digital remote sensing including multispectral scanners ( Landsat and SPOT) radar and thermal imagery. Hands-on image processing including filtering, image display, ratios, classification, registration, and accuracy assessment. GIS as it applies to image processing. Discussion of practical application. Use of ERDAS image processing software. Knowledge of PCs and DOS required. Prereq: NR 857 or equivalent. Special fee. 3 cr.

860. Geographic Information Systems in Natural Resources
Introduction to the use of geographic information systems (GIS) for use with natural resources including data input, manipulation, storage, analysis, and display. Accuracy of spatial data and use of digital elevation models. Discussion of practical applications. Use of PC ArcInfo software. Prereq: permission. Special fee. 3 cr.

901. Special Topics in Natural Resources
Study of any one of a variety of special topics dealing with the general areas of natural resources and the environment. Course involves hands-on learning experience with a combination of lecture, lab, and field exercises. Generally offered off campus as professional development. 1–4 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. Prereq: permission. 3 cr.

947. Current Issues in Ecosystem Ecology
Examines current issues in ecosystem ecology and biogeochemistry by weekly discussion of primary research articles. Topics covered include elemental interactions in...
biogeochemical processes, mechanisms regulating nitrogen losses from terrestrial ecosystems, and hydrologic-chemical interactions in streams and groundwater. Special fee. 1 cr.

953. Decision Analysis
Theory and applications of decision science technology to natural resource situations. Mathematical programming, regional impact analysis, and decision theory. Prereq: permission. Lab. 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. 1 cr. Cr/F.

996. Natural Resource Education
Responsibilities include set-up, teaching, and grading of one lab section per week or equivalent lecture experience. Required of all M.S. degree students in the department. 1 cr. Cr/F.

998. Directed Research
Hours and credits to be arranged. Prereq: permission. Not available if credit obtained for NR 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.

Environmental Conservation (EC)

810. Environmental History
History of ideas, beliefs, values, and actions regarding the environment and the socioeconomic matrix within which they lie, with special reference to the American experience. Prereq: permission. 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, land-use economics or equivalent. 3 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.)

820. Forest Genetics
Genetics of forest tree improvement; variation in natural populations, breeding methods, physiological characteristics, 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.)

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.

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.

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
Discussions and presentations on forest dynamics to include soil-site quality evaluation, individual tree growth, stand growth and yield, and forest management, and related resources politics. 4 cr.

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 following a workshop type format. Presentations by faculty, students, and outside speakers. Emphasis placed on management impacts on biological systems. Sessions on theory and current literature are followed by data analysis and practical sessions, as appropriate. Subject areas include conservation biology, conservation genetics, climate change, old growth forests, and the impact of management on natural forest ecosystems. Prereq: permission. 3 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: NR 830 or permission. 3 cr.

995. Investigations in Environmental Conservation

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 re-
lated 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. 4 cr. (Not offered every year.)

808. Soil Physics
Physical properties of soils and how they relate to the movement of water, solutes, and contaminants in saturated and unsaturated soils. Methods of measuring and characterizing soil physical properties. Applications to environmental problems, including land-based disposal systems, hazardous waste site investigation and remediation, and soil-water management. Prereq: basic courses in mathematics, chemistry, and physics/or permission. 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. Elective only after consultation with the instructor in charge. 1–4 cr.

Water Resources (WARM)

800. Issues in Water Resource Management
Detailed consideration of current issues in water resource management in a seminar format. Topics vary each year but have included risk assessment, riparian rights, and the impact of water diversion on the water quality and ecology of lakes. Special fee. Prereq: watershed water quality management. 2 cr.

811. Wetland Resource Management
Analysis of the natural resources of coastal and inland wetlands and environmental problems caused by human use and misuse of these ecosystems. Special fee. Prereq: gen. ecology or permission. 3 cr.

813. Field Wetland Ecology
Field investigation of coastal and inland wetland types. First half of course consists of field trips to visit and sample regional wetlands. Second half of course consists of methods used to analyze field samples from wetlands. Prereq: present or past enrollment in WARM 811. Special fee. Lab/field trips. 2 cr.

816. Wetland Delineation
Examination of the soils, vegetation, and hydraulic functions of coastal and central New England wetlands. Students are responsible for the collection and identification of aquatic plant species, the description of wetland soils, and the delineation of wetland boundaries. Two course options meet over five weeks (Friday and Saturday or Wednesday and Thursday) during July and August; 4 hrs. of lecture, 4 hrs. of lab, and 8 hrs. of fieldwork per week. For grad students and professionals. Prereq: permission. Special fee. 4 cr.

818. Wetland Evaluation
Lectures and field trips covering the theory and practice of wetland evaluation techniques with emphasis on the method for the comparative evaluation of non-tidal wetlands in New Hampshire. Prereq: grad. students and working professionals. Field trips. Special fee. 2 cr.

819. Wetlands Mitigation and Restoration
Assessing the problems of wetland loss. 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.)

821. Biological Aspects of Water Resources Management
Impact of various water quality problems (e.g., excessive nutrient loading, organic matter loading, contamination by trace organic compounds) on the ecology of fresh waters, including microorganisms, aquatic invertebrates, algae, and fish. Design of impact assessment studies and data interpretation. Special fee. Lab/field trips. Prereq: watershed water quality management or permission. 4 cr.

Wildlife (WILD)

809, 810. Wildlife Management Seminar
Discussions and assigned reports on current investigations and developments in wildlife management. Prereq: undergraduate courses in wildlife management; permission. Special fee. 1–4 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, non-game, 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. Prereq: permission. 1–4 cr.

Natural Resources Ph.D. Program (NRP)

Chairperson: John D. Aber
Professors: John D. Aber; S. Lawrence Dingman; Robert C. Harris; Robert O. Harter; Dennis Meadows
Associate Professors: William B. Bowden; Robert T. Eckert; Richard W. England; John M. Halstead; Theodore E. Howard; Barrett N. Rock
Graduate Program Coordinator: John D. Aber

Degree Offered
The Natural Resources Program is an interdepartmental program offering only the Ph.D. degree for interdisciplinary work in areas related to the understanding and management of natural resources in the broadest context. Areas of study include ecosystem science, biogeochemical cycling from local to global scales, social science and policy issues, and interdisciplinary natural resources management.

Admission Requirements
Applicants to the Natural Resources Program come from a wide range of undergraduate majors. Individuals are judged as to the quality of their undergraduate work and its relevance to the particular area of study they propose to
pursue. Certain applicants may be admitted with deficiencies identified by their adviser and by the Executive Committee. These deficiencies must be corrected through coursework in the first year in the program.

In addition, applicants must identify an adviser before being admitted, and this adviser must agree to take on the new student.

Applicants with master's degrees are judged on the basis of both undergraduate and graduate records. Coursework done at the master's level is, with appropriate approvals, counted against credit hour requirements for the degree.

**Ph.D. Degree Requirements**

The total coursework requirement is 48 credits, of which only 12 may be in the minor. The total degree requirement is 78 credits, of which only 36 may be in the minor. The total degree requirement is 81 credits, of which only 36 may be in the minor.

Ph.D. applicants are required to have a good academic record, satisfactory scores on either the Graduate Record Examination general test or the Miller Analogies Test, and completion of coursework in statistics and research. In addition, a minimum of one year experience as a professional nurse is preferred. Applicants whose baccalaureate degree is in a discipline other than nursing must also complete an autobiographical essay.

**Admission Requirements**

Registered nurses who hold a baccalaureate degree in either nursing or another field are considered for admission. Applicants are required to have a good academic record, satisfactory scores on either the Graduate Record Examination general test or the Miller Analogies Test, and completion of coursework in statistics and research. In addition, a minimum of one year experience as a professional nurse is preferred. Applicants whose baccalaureate degree is in a discipline other than nursing must also complete an autobiographical essay.

**M.S. Degree Requirements**

The program for the master of science degree includes a total of 39 credits for the clinical nurse specialist and nursing administration specialties, and 45 credit hours for the family nurse practitioner specialty. It is designed to be completed within one and one-half to 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:

- Core courses (9 credits): Courses required of all students include: 900, The Discipline of Nursing; 901, Nursing and Change in Health Care Services; and 905, Research in Nursing.
- Specialty courses (21-27 credits): Courses required for each area of specialization include, for clinical nurse specialist: 908, Clinical Application of Human Physiology; 909, Health and Illness Appraisal; 911, Clinical Decision Making: Nursing Diagnostics; 912, Clinical Decision Making: Nursing Therapeutics; 919, Role Practicum and Seminar in Nursing Care of Adults; and 920, Administrative Theories of Nursing. For nursing administration: 920, Administrative Theories of Nursing; 921, Administrative Context for Quality Nursing Care Delivery; 922, Resource and Financial Management in Nursing; 929, Role Practicum and Seminar in Nursing Administration; and HMP 810, Financial Management for Clinicians; and HMP 903, Health Care Planning. For family nurse practitioner: 907, Pharmacology; 908, Clinical Application of Human Physiology; 909, Health and Illness Appraisal; 930, Family Health: Care of the Middle and Older Adult; 931, Family Health: Care of Children; 932, Nursing Care of the Chronically Ill; 933, Practicum in Primary Care of the Chronically Ill; 939, Seminar and Practicum in Primary Care of Families.

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 3 credits, the student will select a 3-credit elective associated with and supportive of the project.

- 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. Nursing and Change in Health Care Services**

Emphasizes identifying emerging issues that have an impact on the health care system and determining nursing's role in adapting to address these issues. Students analyze problems and proposed solutions from a nursing perspective with reasoned approach to their resolutions. Prereq: permission. 3 cr.
905. Research in Nursing
Provides overview of current state-of-the-art research in nursing. Emphasis on critique of research findings and application of research to clinical practice. Prepares student to work collaboratively with expert researchers in either academic or clinical settings. Discusses types of research designs and qualitative and quantitative methods. Critique process focuses on individual components of research study, including the theory, purpose, sample, data collection procedures, and analysis. Includes ethical issues of scientific fraud and misconduct and issues of human subjects. Prereq: permission. 3 cr.

907. Pharmacology
Principles of pharmacodynamics and pharmacokinetics relevant to primary care practice. Focuses on major classes of drugs with an emphasis on knowledge necessary for prescriptive authority. 3 cr.

908. Clinical Application of Human Physiology
Examines human physiologic function and interaction of selected body systems in maintaining health. Clinical correlation strategies used to examine implications of recent advances in selected areas of human physiology to better understand the human body and its functioning in health and illness. Stresses application of course materials to advanced nursing practice in a variety of settings. Prereq: permission. 3 cr.

909. Health and Illness Appraisal
Advanced health assessment including communication strategies, functional health pattern assessment, advanced physical assessment, screening diagnostic tests, developmental evaluation, and clinical decision making. Lab and clinical component. Prereq: permission. 3 cr.

911. Clinical Decision Making—Nursing Diagnostics
Examines the cognitive strategies nurses use to identify client health problems, health-related life issues, and dysfunctional health patterns. The student conducts in-depth inquiries into client health problems/issues occurring in a client population of interest. Prereq: permission. 3 cr.

912. Clinical Decision Making—Nursing Therapeutics
Examines the scientific, ethical, and cognitive strategies nurses use to select and design nursing interventions and nursing actions. Also considers underlying values. In-depth inquiries into interventions used to manage problems occurring in a client population of interest. Evaluates research and analyzes theoretical support for the interventions. Prereq: permission. 3 cr.

919. Practicum and Seminar in Clinical Specialization
The practicum enables students to deliver direct client services and participate in other activities of the clinical nurse specialist (CNS) role under the guidance of a preceptor specialized in working with the population of interest. The seminar provides opportunity to discuss various implementations of the CNS role, relationships with other nursing administrators, and issues encountered in collaborating with other health care providers. Prereq: permission. 6 cr.

920. Administrative Theories in Nursing
Application of administrative theories and organizational behavior concepts to the practice of nursing administration in current and emerging health care settings. Examines organizational structure, motivation, leadership/management, decision making, creativity, and change. Prereq: permission. 3 cr.

921. Administrative Context for Quality Nursing Care Delivery
Identification of strategies to create an organizational context to enhance effective and efficient quality nursing practice in a variety of health care settings. Intra- and interdepartmental effectiveness, care delivery models, governance models, patient/client focused redesign, operations improvement programs, and human resource management are studied within an open systems focus. Prereq: permission. 3 cr.

922. Resource and Financial Management in Nursing
Strategies for the effective use of human and financial resources in health care systems. Explores budget development and control, business plan development, skill mix, costing of nursing services, computer uses, classification of systems and acuity determination of staffing/skill mix, and marketing of nursing service strategies in relation to fiscal responsibilities of the nurse and administrator. Prereq: financial management for clinicians or permission. 3 cr.

929. Practicum and Seminar in Nursing Administration
Individualized practicum experience arranged to assist student in applying theoretical knowledge in the practice setting and to achieve personal goals related to development as a nurse administrator. Seminar topics selected to reflect issues arising from practicum experiences but will include ethical administrative considerations and nursing administration in future health care delivery systems. Prereq: permission. 6 cr.

930. Family Health: Care of the Middle and Older Adult
Clinical course covering the primary care management of healthy adults through the lifespan with a focus on health maintenance and disease prevention. Focuses on evaluation and management of common acute and chronic adult health care problems. Covers major causes of adult morbidity. Special fee. Prereq: NURS 908, 909. Coreq: NURS 907. 4 cr.

931. Family Health: Care of Children
Clinical course covering the primary care management of the healthy child including assessment and management of common clinical problems. A developmental perspective is taken to examine child health evaluation and maintenance from infancy through adolescence. Also covers common acute illnesses of childhood. Special fee. Prereq: NURS 908, 909. 4 cr.

932. Nursing Care of the Chronically Ill
Systems approach to chronic and complex health and illness problems affecting families through the lifespan. Focuses on nursing care issues relevant to these problems. Covers select major chronic illnesses. Discusses family aspects and rehabilitation issues related to variations in treatment. Prereq: NURS 907, 908, 909. Coreq: NURS 933. 3 cr.

933. Practicum in Primary Care of the Chronically Ill
Clinical applications of the systems approach to chronic and complex health and illness problems affecting families through the lifespan. Focuses on primary care issues relevant to these problems. Covers select major chronic illnesses. Special fee. Prereq: NURS 907, 908, 909. Coreq: NURS 932. 1 cr.

939. Seminar and Practicum in Primary Care of Families
Final integrative clinical course that allows for intensive application of primary care knowledge and skills in practice. Seminar allows for in-depth analysis of various clinical problems and role issues. Students are actively involved in a primary care setting appropriate to their area of study. Extensive clinical experience under the guidance of a preceptor. Special fee. Prereq: NURS 930, 931, 933. 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. Prereq: permission. 1–3 cr.
898. Master's Project
Opportunity to develop, implement, and evaluate a project relevant to the practice setting. Prereq: permission. Variable 1–6 cr. (Total must equal 3 or 6 cr.) An IA course. Cr/F.

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

Occupational Education (AOE)

Chairperson: Bruce E. Lindsay
Professors: William H. Annis; David L. Howell
Associate Professor: Lewis Roberts, Jr.
Assistant Professor: Patricia Dugan Bedker
Graduate Program Coordinator: David L. Howell

Degree Offered
The program in adult and 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, because 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 AOE 912, Introduction to Social Sciences Research; AOE 998, Adult and Occupational Education Seminar (1–2 cr.); and AOE 802, Concepts of Adult and Occupational Education. Students concentrating in the area of vocational/technical education must also complete AOE 901, Advanced Methods and Materials of Instruction. Students concentrating in adult education are required to take AOE 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 Adult and Occupational Education
Modularized instruction of in-service education. Focus varies with the needs of the student. May be repeated up to 8 credits. Special fee. 1–4 cr.

802. Concepts of Adult and Occupational Education
Development of occupational 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 adult education. Special attention on the adult as a learner, volunteer management, evaluation and accountability, experiential learning, adult education. Required of all degree candidates in AOE 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: microcommunications or permission. 4 cr.

896. Investigations in Adult and Occupational Education
A) Career Education; B) Secondary Education; C) Postsecondary 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/Technical 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. 1–4 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.

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 in 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 Social Sciences Research
The course is designed to develop a knowledge and understanding of the principles and techniques of scientific research in the social sciences. 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. Adult and Occupational 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)

Chairperson: Kenneth C. Baldwin

Professors: Wendell S. Brown; David L. Gress; David E. Limbert; Godfrey H. Savage; Kondagunta Sivaprasad

Associate Professors: Kenneth C. Baldwin; Thomas P. Ballesteros; Jean Benoit; Barbaros Celikkol; Pedro A. de Alba; Nancy E. Kinner; Donald W. Melvin; M. Robinson Swift

Graduate Program Coordinator: Kenneth C. Baldwin

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, hydromechanics 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.

887. 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. (Also offered as CIE 857 and ME 857.) 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 instrumentation 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.

#897. 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.

999. Master's Thesis
6 cr.
appropriate motor programs for ameliorating physical and motor dysfunction in special populations. Prereq: kinesiology and neurology or motor learning or equivalent. 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.

840. Athletic Administration
Introduces basic management components and processes used in the successful administration of school and college athletic programs. Topics include: planning, organizing, and managing sports programs, personnel, and policies; game scheduling; finances and facilities; equipment and event management; marketing and media relations; and key legal issues. Prereq: 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.

842. Diagnostic Motor Assessment
Overview of diagnostic and prescriptive procedures used in special physical education. Psychomotor assessment instruments utilized by practitioners in the field are described, which can be applied when discerning level of performance in children with special needs. Prereq: measurement procedures in physical education. Lab. 3 cr.

844. Medical and Exercise Issues of Disabling Conditions
A study of disabilities caused by anomalies found within neurological, cardiorespiratory, sensory, and musculoskeletal systems. Exercise and programming techniques necessary for physical and motor development relative to present physiological and kinesiological functioning are addressed. Prereq: kinesiology or exercise physiology or equivalent. 3 cr.

850. Theories of Motivation in Sport and Exercise
Presents the social cognitive theories of achievement motivation as they relate to sport and exercise participation. Special consideration is given to the way coaches, exercise leaders, and physical education teachers should motivate individuals. Prereq: introduction to psychology. 4 cr.

870. Psychological Skills in Performance
Provides essential elements of psychological skills training in performance. Focuses on mental aspects that enhance or inhibit physical performance. Theory, direct skill acquisition, and skill application are all integral to this course. Topics include progressive relaxation, meditation, hypnosis, goal setting, and stress inoculation testing. Special fee. Prereq: intro. to psych. or psychological factors in sport. 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. Prereq: permission. 4 cr.

882. Therapeutic Applications of Adventure Programming
Examines the use of adventure activities as elements of therapeutic treatment plans. Incorporates theoretical seminars and associated practical experiences. Prereq: outdoor ed. phil. and methods or theory of adventure ed. and permission. 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. Practice and theory of behavior management, to be applied with children who continually misbehave, exhibit behavior disorders, or have an emotional disturbance. Prereq: permission. Lab. 4 cr.

890. Social and Health Issues in Sport Psychology
Current trends in social and health psychology as they pertain to the competitive sports environment. Examines areas such as adherence motivation, bulimia and anorexia in athletes, self-theory, exercise and depression, and substance abuse in athletes. Prereq: intro. to psych. or motor learning and control. 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. 1-4 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 science concentration. 1 cr. Cr/F.

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 individuals and/or individuals with disabilities. Focus on issues associated with planning, developing, implementing, and evaluating vocational programs for special needs learners. 4 cr.

909. Special Physical Education Practicum/Seminar
Practicum/Seminar
Prepares master teachers to employ 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 are congruent with the idiosyncrasies of the public schools. (May be taken twice for credit.) 2 cr. Cr/F.

950. Internship
Experiential learning in a setting appropriate to the student's objectives. A 4-credit internship requires a minimum of 300 hours experience. Fewer credits require proportionally fewer hours. A) Exercise Science. Clinical work, normally in a hospital or laboratory setting, involving exercise physiology, graded exercise testing, exercise prescription, and/or cardiac rehabilitation. Must have completed all required coursework except thesis. B) Special Physical Education. C) Sport Studies. 2-4 cr. Cr/F.

899. Master's Thesis
6 cr.

Physics (PHYS)

Chairperson: John R. Calarco
Professors: Roger L. Arnolgy; L. Christian Balling; John R. Calarco; Edward L. Chupp; John F. Dawson; Jochen Heiseberg; Joseph Hollweg; Richard L. Kaufmann; Robert H. Lambert; Martin A. Lee; Harvey K. Shepard; Robert E. Simpson; Roy B. Torbert; John J. Wright
Research Professors: Terry Forbes; William R. Webber
Associate Professors: Olof Echt; F. William Hersman; Dawn C. Meredith; Eberhard Möbius; James M. Ryan
Research Associate Professors: David J. Forrest; W. T. Vestrand
Assistant Professor: Robert E. Leuchtner
Research Assistant Professors: Philip A. Isenberg; Lynn M. Kistler; Craig A. Kletzing; Mark L. McConnell; Terrance G. Onsager
Graduate Program Coordinator: Dawn C. Meredith
Graduate Program Recruiter: F. William Hersman

Degrees Offered
The Department of Physics offers the degrees of master of science and the doctor of philosophy. Areas of specialization are space physics and astrophysics, nuclear physics, solid-state physics, and nonlinear dynamical systems.

Admission Requirements
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 805, 931, 939, 941, and 943-944. Students in the M.S. program are not required to take the Ph.D. qualifying examination. 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.

Ph.D. Degree Requirements
The courses required for a doctor of philosophy degree in physics are (1) 805, 931-932, 935, 939, 941-942, 943-944, either 940 or 955; and (2) any additional four courses at the 900 level, excluding 969, 979, 989, 997, and 999. For students doing Ph.D. research in astrophysics or space physics, one of these four courses must be 951. With appropriate additional work, a student may petition to receive credit for one of the following courses: 810, 812, 818, or 851. Admission to candidacy for the degree is based primarily on 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 and must be passed by the end of the third year. Upon completion of a dissertation, doctoral candidates will take an oral examination based on 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 (EOS). (See the list for EOS in this catalog.) Contact the department chairperson or graduate adviser for details.

805. Experimental Physics
Experiments in nuclear, solid-state, and surface physics. Includes discussion of laboratory techniques, data analysis, and data presentation. Special projects assigned to individual students. 4 cr.

810. Introduction to Astrophysics
Review of the sun, stars, Milky Way, external galaxies, and expansion of the universe. Recent discoveries of radio galaxies, quasar 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. 4 cr. (Normally offered every other year.)

811. Topics in Modern Physics
Discussions, lectures, and laboratory work on topics of current interest in physics. An introductory course for secondary school teachers and others with some science background. 1-4 cr. (Not offered every year.)

812. Physics of the Ionosphere
Introduces basic plasma physics using a case study of the Earth's ionosphere and its connection both to the upper atmosphere and to the Earth's magnetosphere. Topics include single-particle motion, fluid and kinetic descriptions of ionospheric plasma, wave propagation, and instabilities. Prereq: electric and magnet I or equivalent; Calculus II. (Also offered as EOS 812.) 4 cr.

818. Introduction to Solid-State Physics
Crystal structure, diffraction, lattice vibrations, electronic and optical properties of metals and semiconductors; selected topics in modern condensed matter physics. Prereq: PHYS 801, 803, or equivalent. 4 cr. (Normally offered every other year.)

851. Scientific Computing
Introduces the tools and methodology of scientific computing via the examination of interdisciplinary case studies from science and engineering. Problems are solved on various hardware platforms using a combination of software and data visualization packages. Prereq: intro. to computer programming with FORTRAN or C; calculus; linear algebra; ordinary differential equations; physics. 4 cr.

895. Independent Study
Individual project under direction of a faculty adviser. 1-8 cr.

931-932. Mathematical Physics
Complex variables, differential equations, asymptotic methods, integral transforms, special functions, linear vector spaces and matrices, Green's functions, and additional topics selected from integral equations, variational methods, numerical methods, tensor analysis, and group theory. 3 cr.

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, 939, or 943. 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. The material covered is at the level of the text by J. D. Jackson, Classical Electrodynamics. 3 cr.

943-944. Quantum Mechanics
Introduces non-relativistic quantum theory, covering wave mechanics, Dirac notation, angular momentum, the use of perturbation theory to calculate atomic energy levels, the interaction of atoms with radiation, and various approaches to calculating the differential scattering cross-section. 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, 941, and 942. 3 cr. (Normally offered every other 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 are reviewed. 3 cr. (Normally offered every other 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. Transport processes, waves, shocks, and instabilities in the solar wind. The basic equations of energetic particle transport. Solar modulation of solar and galactic cosmic rays. Interaction of energetic particles with shock waves. Salient data are reviewed. 3 cr. (Normally offered every other year.)

955. Geophysical and Astrophysical Fluid Dynamics
Applies principles of fluid dynamics and magnetohydrodynamics to the Earth's atmosphere and oceans and to space plasmas. Emphasizes common problems and techniques. Topics include mass, momentum, energy conservation; static equilibrium; quasigeostrophic flow; waves (acoustic-gravity, planetary, magnetoacoustic); surface waves in the ocean and in space; instabilities (convective, baroclinic Rayleigh, Taylor, Kelvin Helmholtz); 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. (Normally offered every other year.) (Also offered as EOS 955.)

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. (Normally offered every other 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. (Normally offered every other year.)

965. Advanced Solid-State Physics
Theory of crystalline metals, semiconductors, and insulators. Selected topics from the following: surfaces, films, quantum dots, clusters, solid-state devices. Prereq: PHYS 935, 941, 943. 3 cr. (Normally offered every other year.)

969. Nuclear Physics Seminar
Lectures and discussion of current topics in nuclear and particle physics. 1-3 cr. (Not offered every year.)

979. Nonlinear Studies Seminar
Lectures and discussion of current topics in the interdisciplinary field of nonlinear dynamics. 1-3 cr.

987. Magnetospheres
Introduces plasma physics of the interaction of solar and stellar winds with planets having internal magnetic fields, most predominantly, the Earth. Both MHD and kinetic descriptions of internal and boundary processes of magnetospheres as well as treatment of the interaction with collisional ionospheres. Flow of mass, momentum, and energy through such systems. Prereq: PHYS 951, 952; or permission. (Also offered as EOS 987.) 3 cr. (Normally offered every other year.)

988. High Energy Astrophysics
One-semester course on the physical principles underpinning the field of high energy astrophysics. Subjects covered include production, detection, and transport processes of neutral and charged high energy particles and photons. Emphasizes the applications of these processes to the detection and measurement problem and theory of telescope design. Uses astrophysical examples to illustrate the subject matter. First part serves as a basis for discussing the astrophysics of the heliosphere, including solar flares, galactic and solar cosmic rays, and the influence of the Earth's magnetic field on the cosmic rays. Prereq: PHYS 941, 942, and 944. (Also offered as EOS 988.) 3 cr. (Normally 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. (Not offered every year.)

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. (Not offered every year.)
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 requirement 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.

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.)

806. Biology of Weeds

808. Biology of Weeds Laboratory
Application of weed identification and weed control practices, considering various types of crops (including ornamental), cultural control, herbicide equipment, application, and safety. Environmental concerns. Field trips. Special fee. Coreq or prereq: PBIO 806. 2 cr.

809. Plant Stress Physiology
Examines the physiological and biochemical mechanisms of plant response to abiotic stresses including drought, salt, high and low temperature, visible and ultraviolet radiation, heavy metals, and air pollutants. Discusses current hypotheses, agricultural and ecological implications. Prereq: plant physiology; biochemistry/or permission. 3 cr.

813. Photosynthesis
The physiology and biochemistry of photosynthesis in higher plants and microorganisms; light reactions, electron transport, membrane structure and function, carbon assimilation pathways, energy conservation, and metabolic regulation. Agronomic and ecological aspects of photosynthesis 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 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. Special fee. 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 habitats; 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 plant and phytoplankton in local marine and freshwater habitats. Identification, systematic, and evolutionary classification and individual collection trips. Prereq: principles of biology II, or introductory botany, or evolution of plants. Lab. 4 cr. (Not offered every year.)

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: principles of biology or elementary botany or survey of the plant kingdom. 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.

825. Marine Ecology
Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prereq: general ecology; permission. Marine invertebrate zoology, oceanography, and statistics desirable. (Also offered as ZOOL 825.) 4 cr. (Not offered every year.)

827. Algal Physiology
Survey of major topics in the physiology and biochemistry of marine and freshwater 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.)

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. (Not offered every year.)

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.)
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.) Special fee. Lab. 5 cr.

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

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. (Not offered every year.)

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.)

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.)

865. Molecular Biology and Biochemistry of Plants
Molecular mechanisms and regulation of plant metabolic functions. Structure and function of cellular constituents of plants; role of secondary metabolites. Emphasis on developments in current literature. Prereq: general biochemistry or principles of biochemistry or permission. Complements PBI0 875. (Also offered as BCHM 865.) 3 cr.

867. Advanced Systematic Botany
Principles of plant classification and rules of nomenclature; plant families; field and herbarium work. Prereq: plant taxonomy. 4 cr.

873. Breeding Improved Varieties
Techniques for creating new varieties of crop and ornamental plants. Discussion and assigned readings in crop breeding. Prereq: genetics. 4 cr. (Not offered every year.)

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: PBI0 875. (Also offered as GEN 874.) 3 cr. (Not offered every year.)

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. Special fee. (Also offered as GEN 875.) 2 cr. (Not offered every year.)

876. Radiation Biology

895. Investigations in 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) Botanical Teaching; J) Morphology; K) Cell Physiology; L) Scientific Writing; M) Microtechnique; N) Cell and Tissue Culture; O) History of Botany; P) Genetics; Q) Plant Utilization. Individual projects under faculty guidance. Prereq: permission. Lab. 4 cr. (4 cr. maximum per semester for any single section.)

908. Plant Physiology Laboratory
Techniques of plant physiology, effects of plant growth regulators on plant growth and development, bioassays, enzyme kinetics, cell/tissue culture, and plant-water relations. Special fee. 2 cr.

995. Investigations in Plant Biology

997. Graduate Seminar
Library research and discussion of current topics in plant biology. Required of all graduate students majoring in plant biology. 1-3 cr.

999. Doctoral Research

Political Science (POLT)

Chairperson: B. Thomas Trout
Professors: Bernard K. Gordon; David L. Larson; David W. Moore; George K. Romoser; B. Thomas Trout; Susan O. White
Associate Professors: Warren R. Brown; Robert E. Craig; Judith A. Gentleman; John R. Kayser; Lawrence W. O'Connell; Clifford J. Wirth
Assistant Professors: Anne Marie Cammisa; 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 in a closely related field. Where undergraduate preparation has been insufficient, applicants may be admitted provisionally 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 M.A. in political science is available to full-time and part-time students. The program has three goals: to assure familiarity with the breadth of the discipline; to provide training in research techniques; and to allow each candidate an opportunity to develop special familiarity with a particular field. Accordingly, the M.A. program includes a master’s thesis and the following course-related requirements: one advanced course or seminar in each of the four fields offered by the department; two additional advanced courses or seminars offered by the department in a related discipline; one advanced course in research techniques and methods; and the master’s thesis in the selected field of concentration. Each candidate must complete seven courses or seminars (28 credits) and the thesis (8 credits) for a total of 36 credits.

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 4-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, 4 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, intergovernmental 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.

807. Cases in Public Management
Policy case studies emphasizing politics, organizational structure, and interorganizational behavior; management case studies emphasizing behavior, human relations, personality, and intraorganizational dynamics; and simulation and role-playing exercises. 4 cr.

Political Thought

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

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 bureaucracies. 4 cr.

International Politics

8860. Theories of International Politics and Integration
General explanations of the behavior of nations; theory and practice of supranational 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. Special fee. 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 to both domestic and 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 engages 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 carries 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.

Psychology (PSYC)
Chairperson: Victor A. Benassi
Professors: William M. Baum; Victor A. Benassi; Peter S. Fernald; Kenneth Fuld; John A. Nevin
Associate Professors: Ellen S. Cohn; Earl C. Hagstrom; John E. Limber; Robert G. Mair; John D. Mayer; Kathleen McCartney; Carolyn J. Mebert; Edward J. O'Brien; William Stine; Rebecca M. Warner; Daniel C. Williams; William R. Woodward
Assistant Professor: Elizabeth L. Stine
Graduate Program Coordinator: William M. Baum
Graduate Admissions Committee Chair: Ellen S. Cohn

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/personality 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 or 908), eight graduate seminars, 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 in either 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 on receiving the master's degree, passing 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 biochemical mechanisms underlying in-
Evolution, Behavior, and Culture
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.

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.

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.

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.

Graduate Proseminar
Students and graduate faculty in psychology meet periodically for a mutual exchange on current issues in psychology. 0 cr. Cr/F.

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.

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.

Mathematical Methods and Behavioral Models
Equations, transformations, and graphs; fundamentals of differential equations; stochastic processes and probability distributions other than Gaussian; applications to selected models of behavior. Prereq: PSYC 906 or permission. 4 cr.

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.

Advanced Seminar in Cognition
An in-depth examination of one or more specific topics in cognition including issues in memory, attention, the use and development of language, and cognitive science. May be repeated for credit. 4 cr.

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.

Advanced Seminar in Physiological Psychology
In-depth examination of a specific topic in the neurosciences. Topics vary depending on interests of instructor and students. Prereq: PSYC 831 or permission. May be repeated for credit. 4 cr.

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.

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.

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.

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.

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.

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.

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.

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.

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.

Master's Thesis
4 cr. per semester in each of two semesters or 8 cr. in one semester. Maximum 8 cr. Cr/F.

Doctoral Research
Resource Administration and Management (RAM)

Chairperson: Bruce E. Lindsay
Professors: John E. Carroll; Edmund F. Jansen, Jr.; Bruce E. Lindsay
Associate Professors: Robert T. Eckert; John M. Halstead; Theodore E. Howard; Alberto B. Manalo; Douglas E. Morris; Gus C. Zaso
Assistant Professor: Robert A. Robertson
Graduate Program Coordinator: Edmund F. Jansen, Jr.

Degree Offered
The Department of Resource Economics and Development coordinates the interdisciplinary master of science degree program in resource administration and management. Students may specialize in management of publicly and privately owned natural resources or in administration of natural resource laws and policies.

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. A minimum of three courses in the areas of ecology or natural resources and intermediate microeconomics is required. Persons having professional experience in resource administration, management, or related areas receive priority for admittance to the program. An applicant is required to submit an essay of up to 2,000 words describing his or her background and goals.

Applicants with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. The Graduate Record Examination general test is required of all applicants.

M.S. Degree Requirements
The master of science degree in resource administration and management is conferred upon successful completion of the following:

1) A program amounting to not less than 34 credits including the following course requirements or equivalent:

- RAM 993, Seminar, 1 cr.; RAM 903, Approach to Research, 2 cr.; quantitative methods or analytical techniques, 3-4 cr.; RAM 911, Natural and Environmental Resource Management, 4 cr.; RECO 808, Environmental Economics, 4 cr.; RAM 912, Administration of Resource Laws and Policies, 4 cr.; and RAM 898, Directed Research, 4-6 cr., or RAM 899, Thesis, 6-10 cr.
- 2) A final oral and/or written examination.

- 896. Investigations in Resource Management and Administration
  A) Resource Administration; B) Resource Management; C) Resource Policy; D) Public Laws and Resources. Prereq: permission. May be repeated. 2-4 cr.

- 898. Directed Research
  Hours and credits to be arranged. Not available if credit obtained for RAM 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 RECO 903.) Prereq: permission. 2 cr.

- 911. Natural and Environmental Resource Management
  Fundamental economic, aesthetic, and ethical principles involved in the management of renewable natural resources. Ways to apply these principles in the formulation and evaluation of resource-management policies, including the management of specific renewable resources, soils, water, forests, and wildlife. (Also offered as RECO 911.) Prereq: permission. 4 cr. (Offered every other year.)

- 912. Administration of Resource Laws and Policies
  Legalistic, policy, and political science aspects of natural and community resource administration; concepts of private property, home rule, social value, tradeoffs, and bureaucracy as elements in administration. Prereq: permission. Special fee. 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 RECO 993.) 1 cr. Cr/F.

- 899. Master's Thesis
  6-10 cr.

Resource Economics (RECO)

Chairperson: Bruce E. Lindsay
Professors: Edmund F. Jansen, Jr.; Bruce E. Lindsay
Adjunct Professor: George Frick
Associate Professors: John M. Halstead; Alberto B. Manalo; Douglas E. Morris
Graduate Program Coordinator: John M. Halstead

Degree Offered
The Department of Resource Economics and Development offers the master of science degree in resource economics with specializations in agricultural economics; community and regional economics; land economics; water economics; and environmental economics.

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. Four or more undergraduate courses in economics or resource economics, including intermediate microeconomics and intermediate macroeconomics, are required, as well as calculus and statistics.

Applicants with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. The Graduate Record Examination general test is required of all applicants.

M.S. Degree Requirements
The master of science degree in resource economics is conferred on successful completion of the following:

1) A program amounting to not less than 30 credits including the following course requirements or equivalent: RECO 993, Seminar, 1 cr.; RECO 903, Approach to Research, 2 cr.; ECON 926, Econometrics I, or ECON 927, Econometrics II; RECO 856, Rural and Regional Economic Development; RECO 815, Linear Programming and Quantitative Models; RECO 904, Production and Resource Economics, or
ECON 976, Microeconomics I; and RECO 898, Directed Research, 4–6 cr., or RECO 899, Thesis, 6–10 cr.
2) A final oral and/or written examination.

801. Statistical Methods I
Analysis of variance and general linear models; measured numbers, nature of statistical evidence, sampling distributions, and principles of statistical inference; application of specific linear models to given sets of data. 4 cr. (Not offered every semester.)

804. Economics of Policy Issues in Food and Natural Resource Use
Economic analysis of current issues affecting food and natural resource use, such as food, safety, air and water pollution, land use and conservation, and waste management. Economic, political, and social consequences of alternative policies and programs are evaluated. Prereq: intermediate microeconomics or permission. 4 cr. (Not offered every year.)

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 or permission. 4 cr. (Not offered every year.)

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 and Quantitative Models
Solving applied economic problems using linear and nonlinear techniques with emphasis on problem specification and interpretation of model results. The unit of analysis includes individuals, firms, or communities as they address contemporary problems in resource allocation, product distribution, and whole-firm organization. Computer applications on both mainframe and personal computers used for managerial decision making. Project required. Prereq: permission. 4 cr. (Offered every other year.)

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.

856. Rural and Regional Economic 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 other year.)

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. Production and Resource Economics
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. (Offered every other year.)

911. Natural and Environmental Resource Management
Fundamental economic, 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 management of specific renewable resources, soils, water, forests, and wildlife. (Also offered as RAM 911.) Prereq: permission. 4 cr. (Offered every other year.)

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: Sally K. Ward
Professors: Melvin T. Bobick; Lawrence C. Hamilton; Bud B. Khleif; Arnold S. Linsky; Stuart Palmer; Murray A. Straus
Research Professor: David Finkelhor
Associate Professors: Peter Dodge; Michael J. Donnelly; Cynthia M. Duncan; Sally K. Ward
Assistant Professors: James Tucker; Heather A. Turner
Graduate Program Coordinator: Cynthia M. Duncan

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 one minor area for intensive study and examination. There are five major substantive areas for possible specialization: deviance, conflict, and control; social psychology; family; social stratification; and social policy and applied sociology. 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 SOC 902, 903, or 904; and Sociological Theory I (911).

2) Register for 1 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 twelve courses in sociology (at least eight 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 (SOC 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, historical methods, 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.

**830. Political Sociology**

Contemporary issues in political sociology with emphasis on the relationship between social class structure and political power. Seminar explores various perspectives on the nature and distribution of power, theories of the state, class structure and political participation, and the politics of policy making. 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.

**861. Population Studies**

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 ethnomethodological 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.
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 sociomovement. 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.

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 intrafamily 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.

990. Teaching Practicum in Sociology
Helps graduate students deal with teaching issues, explore teaching techniques, and improve their teaching skills. Topics include: setting course goals, designing lectures, evaluating student work, leading discussion, and experimenting with innovative teaching techniques. 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.

997. Advanced Special Topics in Sociology
Occasional or experimental offerings. May be repeated for different offerings. 4 cr.

999. Master's Thesis
Usually 6 cr. but up to 10 cr. when the problem warrants.

999. Doctoral Research

Spanish (SPAN)

Chairperson: Barbara H. Wing
Professors: Richard J. Callan; F. William Forbes; Charles H. Leighton
Associate Professors: Bernadette Komonchak; Phoebe A. Porter; Barbara H. Wing
Assistant Professors: John M. Chaston; William Mejías-López; Magda A. Renoldi-Tocalino
Graduate Program Coordinator: F. William Forbes

Degree Offered
The Department of Spanish and Classics offers a master of arts degree in Spanish with courses 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 SPAN 901. Teaching assistants must also take SPAN 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. If the thesis option is selected, it must embody the results of independent investigation, be written in Spanish in a form acceptable to the Spanish section and the Graduate School.

#833. History of the Spanish Language
The evolution of the Spanish language from the period of origins to the present. 3 cr. (Not offered every year.)

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. The Age of Cervantes
Study of the major works of Cervantes and his contemporaries in the context of the historical, literary, and social currents of the time. 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.)

856. Modern Spanish Poetry
Study of selected Spanish poets of the 18th, 19th, and 20th centuries in the context of the historical, literary, and social currents of the times. 3 cr. (Not offered every year.)

857. Spanish Drama of the 20th Century
Study of selected Spanish dramatic works of the 20th century in the context of the historical, literary, and social currents of the times. 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 José Ortega y Gasset. 3 cr. (Not offered every year.)

871. Latin American Drama
From pre-Hispanic origins to the present; modern playwrights of Mexico and Puerto Rico. 3 cr. (Not offered every year.)

872. Latin American Novel
Development from Romanticism to the present; contemporary trends and techniques. 3 cr. (Not offered every year.)

873. Latin American Short Story
Representative authors; stress on 20th century. Principles of interpretation. 3 cr. (Not offered every year.)

874. Major Latin American Authors
3 cr. (Not offered every year.)

890. Grammatical Structure of Spanish
An overview of the grammatical structure of Spanish through an in-depth analysis of both morphology and syntax, with emphasis given to the meaningful contrasts that exist within the Spanish language and 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.

897. Special Studies in Spanish Language and Literature
A) The History of the Spanish Language; B) Medieval Spanish Literature; C) Spanish Literature of the Renaissance; D) Spanish Literature of the Golden Age; E) Spanish Literature of the 18th and 19th Centuries; F) Spanish Literature of the 20th Century; G) Contemporary Spanish Literature; H) Latin American Literature of the 16th and 17th Centuries; J) Latin American Literature of the 18th and 19th Centuries; K) Latin American Literature of the 20th Century; L) Contemporary Latin American Literature; N) Structural and Applied Linguistics; O) Spanish Literary Criticism; P) Latin American Essay; Q) Latin America; R) Spanish Theatre; S) Spanish Poetry; T) Latin American Poetry; U) Archetype Latin American Literature; V) Special Teaching Problems; W) Spanish Civilization and Culture; Z) Latin American Civilization and Culture. Specialized courses covering topics not normally presented in regular course offerings. Prereq: permission of major supervisor. 3 cr.

898. Special Studies in Spanish Language and Literature
A) Hispanic Minorities of the United

Sociology, Spanish
Spanish, Zoology

Assistant Professors: Richard R. Olson; Michelle P. Scott
Adjunct Assistant Professors: David T. Bernstein; Richard Langan; Barry J. Wicklow

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, 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 from 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 thesis defense, which will include questions covering general knowledge in zoology in addition to specific questions relevant to the student's research at the University of New Hampshire.

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. After the successful completion of the language requirement 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 and their ability to carry out basic research in zoology in an oral qualifying examination. Prior to the qualifying examination, the student will present 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 encouraged to obtain some appropriate teaching experience.

804. Endocrinology
Structure and function of vertebrate endocrine systems. Influence of endocrine systems on the physiology of vertebrates, with special reference to mammals. Current investigations of the endocrine system as a regulator and integrator of body functions. Applicants 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 from the Graduate Record Examination. 4 cr. (Also offered as BCHM 804.)

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 include both field and laboratory experimental techniques. Occasional Saturday field trips. 4 cr. (Not offered every year.)

809. Environmental Physiology of Animals
Animals' responses to natural changes or extremes of the physical environment. Emphasis on adaptation of animals to 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: gen. ecol., prin. of animal physiol./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. Zooplankton Ecology
Methods of sampling populations; factors regulating temporal and spatial distribution; trophic interactions of communities, role in nutrient cycle of lakes. Experimental techniques employed in field trips to freshwater habitats. Seminars examine current research. Prereq: gen. ecol. and limnology, ZOOL/PBIO 817, or equivalent; permission. 4 cr. (Not offered every year.)

812. Mammalogy
Evolution, ecology, behavior, physiology, and diversity of mammals. Focuses on conceptual issues, such as the relations of structure, function, physiology, and ecology of species; reproductive physiology and life history strategies; and the evolution of mating systems and social structure. Requires familiarity of mammalian groups to the family level and identification of local fauna to species. Prereq: prin. of biol. or equivalent. Lab. 4 cr. (Not offered every year.)

813. Animal Behavior
Introduces the naturalistic study of animal behavior. Emphasizes the evolution, development, physiology, and ecology of behavior. Topics include the genetic and acquired bases of behavior; neuroethology and behavioral endocrinology; communication; orientation; foraging strategies; reproductive ecology; and the evolution of altruistic behavior. Prereq: principles of biology I and II or equivalent. Lab. 4 cr.

815. Molecular Evolution
Molecular mechanisms of organismal evolution. Emphasis is on integrating evidence from biochemistry, molecular genetics, developmental biology, and organismal studies. Review of population genetics and the neutral theory. Evolution of sex. Genetics of speciation. Methods of reconstructing phylogeny from molecular sequences. Prereq: genetics or permission; some knowledge of statistics plus a computer language (BASIC or PASCAL) is recommended. 4 cr. (Also offered as GEN 815.)

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.

821. Current Topics in Ecology and Evolutionary Biology
Lecture course for advanced students dealing with a current topic in the general area of ecology or evolutionary biology. Possible topics include the structure of ecological communities, recruitment dynamics in marine organisms, genetics of speciation, top-down and bottom-up control of ecological systems, and the ecology of predation, among others. The topic chosen each semester varies, and interested students should check with the department for details. While a textbook may be listed, the course usually relies heavily on direct reference to the current research literature in the field. 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 (organic chem. or equivalent). Recommended: developmental or cell biology (dev. biol. of the vertebrates or invertebrates); biochemistry or physiology (prin. of animal physiol. or gen. limnology). 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. Immunochromatographic techniques, traditional and innovative applications of electron and light microscopy, bioassay, cell culture and transfection, and electrophysiology. Coreq: ZOOL 823. Special fee. 2 cr.

825. Marine Ecology
Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prereq: general ecology; permission. Marine invertebrate zoology, oceanography, and statistics are desirable. (Also offered as PBIO 825.) 4 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 RV Jere A. Chase and to the Jackson Estuarine Laboratory. Prereq: one year of biol. or permission of instructor. Lab. (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. I and II 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 seminars. May include reading, laboratory work, organized seminars, and conferences. Prereq: permission of department chairperson and staff concerned. 1-4 cr.
ics include scientific writing, graphical methods, library techniques, scientific method and experimental design, research techniques available, and similar presentation. 2 cr. Cr/F.

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.)

#926. Comparative Physiology
Nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: ZOOL 823; 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
Trustees, Administrative Officers, and Graduate Council

University System of New Hampshire Trustees

Officers of the Board
Donald G. O'Brien, M.S.
Chair of the Board

Marion E. James, Ph.D.
Secretary of the Board

Harry H. Bird, M.D.
Vice Chair of the Board

Creeley S. Buchanan, B.A.
Treasurer of the Board

Sherilyn Burnett Young, J.D.
Legal Adviser of the Board

Members of the Board
His Excellency Stephen E. Merrill, J.D.
Governor of New Hampshire
Manchester, N.H. (ex officio)

Thomas K. Christo, J.D.

William J. Farrell, Ph.D.
Chancellor, University System
Durham, N.H. (ex officio)

Suzanne M. Fitzgerald
Student Trustee, PSC

Suzanne M. Fortier, M. Ed.

David L. Gagne, M.S.

Louis J. Georgopoulos, B.S.

Jane E. Hager, B.A.

George J. Khoury, B.A.

Charles H. Marston, B.A.
Commissioner of Education
Concord, N.H. (ex officio)

William H. Marston, M.Ed.

Terry L. Morton, M.S.

Dale F. Nitzschke, Ph.D.
President, University of New Hampshire
Durham, N.H. (ex officio)

Stella E. Scamman, B.A.

Judith A. Stumnick, Ph.D.
President, Keene State College
Keene, N.H. (ex officio)

Stephen H. Taylor, B.A.
Commissioner of Agriculture
Meriden, N.H. (ex officio)

John F. Weeks, Jr., B.A.

Donald P. Wharton, Ph.D.
President, Plymouth State College
Plymouth, N.H. (ex officio)

James S. Yakovakis, J.D.

Administrative Officers
 Dale F. Nitzschke, Ph.D.
President

Walter F. Eggers, Ph.D.
Provost and Vice President for Academic Affairs

Fred Schnur, C.P.A.
Vice President for Finance and Administration

James Morrison, Ph.D.
Vice President for Research and Public Service

Daniel A. DiBiasio, Ph.D.
Interim Vice President for Student Affairs

Thomas P. Fairchild, Ph.D.
Dean of the College of Life Sciences and Agriculture
Director of the Agricultural Experiment Station

Brian A. Giles, Ed.D.
Director of the Thompson School of Applied Science

Lyndon Goodridge, Ph.D.
Dean of the Whittemore School of Business and Economics

Peter J. Horne, Ed.D.
Dean and Director of Cooperative Extension

Karol A. LaCroix, Ph.D.
Interim Dean of the Graduate School

William F. Murphy, Ed.D.
Dean of the Division of Continuing Education

Stuart Palmer, Ph.D.
Dean of the College of Liberal Arts

Roger A. Ritvo, Ph.D.
Dean of the School of Health and Human Services

John Resch, Ed.D.
Interim Dean of the University of New Hampshire at Manchester

Otis J. Sproul, Ph.D.
Dean of the College of Engineering and Physical Sciences

Stanwood C. Fish, M.A.
Dean of Admissions* and Financial Aid

Michael C. York, M.L.S.
Interim University Librarian

Stephanie M. Thomas, M.A.
Registrar

* Undergraduate admissions only.

Graduate Council

Karo Il LaCroix, Ph.D.
Interim Dean of the Graduate School, Chairperson

Harry J. Richards, Ph.D.
Associate Dean of the Graduate School, Secretary

Professor of Botany

Professor of History

Associate Professor of Economics

Professor of Zoology

Associate Professor of Computer Science

Associate Professor of Geology

Associate Professor of English

Associate Professor of Civil Engineering

Associate Professor of Nursing

Assistant Professor of Music

(Three graduate students are appointed to this council each year.)
Faculty of the Graduate School

Faculty

(This list is current as of July 1, 1993. The date of appointment appears in parentheses following the faculty member's name.)

*A currently less than 100 percent status.

Aber, John D. (1987) Director of the Complex Systems Research Center and Professor of Natural Resources and Earth, Oceans, and Space; Ph.D., Yale University, 1976.

Aikins, Janet (1979) Associate Professor of English; Ph.D., University of Chicago, 1980.


Arnoldy, Roger L. (1967) Director, Space Science Center and Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Minnesota, 1962.


Baber, Kristine M. (1987) Associate Professor of Family and Consumer Studies; Ph.D., University of Connecticut, 1983.

Baldwin, Kenneth C. (1982) Director of Ocean Engineering Program and Associate Professor of Mechanical Engineering and Ocean Engineering; Ph.D., University of Rhode Island, 1982.

Ballestero, Thomas P. (1983) Director, Water Resources Research Center and Associate Professor of Civil Engineering; Ph.D., Colorado State University, 1981.

Ballington, L. Christian (1967) Professor of Physics; Ph.D., Harvard University, 1965.


*Bornstein, Steven P. (1989) Director of Audiology Clinic and Associate Professor of Communication Disorders; Ph.D., University of Connecticut, 1981.


Boult, Richard J. (1969) Professor of Spanish and the Humanities; Ph.D., St. Louis University, 1965.

Boulton, Elizabeth F. (1988) Station Veterinarian and Assistant Professor of Animal Science; D.V.M., University of Georgia, 1980.


Boy, Angelo V. (1965) Professor of Education; Ed.D., Boston University, 1960.


Bristol, Ralph B., Jr. (1986) Adjunct Associate Professor of Economics; Ph.D., Yale University, 1956.

Brown, Sarah Jo (1990) Assistant Professor of Nursing; Ph.D., University of Rhode Island, 1990.

Brown, Warren R. (1972) Associate Professor of Political Science and Humanities; Ph.D., Claremont Graduate School and University Center, 1976.

Brown, Wendell S. (1974) Director of the Ocean Process Analysis Laboratory and Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., Massachusetts Institute of Technology, 1971.


Calcaro, John R. (1981) Professor of Physics; Ph.D., University of Illinois at Urbana-Champaign, 1969.


Callan, Richard J. (1969) Professor of Spanish and the Humanities; Ph.D., St. Louis University, 1965.
Cammins, Anne Marie (1992)  
Assistant Professor of Political Science; Ph.D., Georgetown University, 1992.

Carey, Gale B. (1989)  
Assistant Professor of Animal Science and Nutrition; Ph.D., University of California at Davis, 1981.

Carney, John J. (1973)  
Associate Professor of Education; Ph.D., Syracuse University, 1973.

Carnicelli, Thomas A. (1967)  
Professor of English and the Humanities; Ph.D., Harvard University, 1966.

Associate 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 J. (1987)  
Associate Professor of Electrical Engineering; Ph.D., University of Michigan at Ann Arbor, 1984.

Celikkol, Barbaros (1969)  
Associate Professor of Mechanical Engineering and Ocean Engineering; Ph.D., University of New Hampshire, 1972.

Chamberlin, Kent (1985)  
Associate Professor of Electrical Engineering; Ph.D., Ohio University, 1982.

Chandler, Donald S. (1981)  
Curator and Associate Professor of Entomology; Ph.D., Ohio State University, 1976.

Chares, Evangelos (1968)  
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-Champaign, 1969.

Chaston, John M. (1989)  
Assistant Professor of Spanish; Ph.D., University of Texas at Austin, 1987.

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.

Cloff, Grant L. (1980)  
Associate Professor of Education; Ph.D., University of Minnesota, 1980.

Clark, Charles E. (1967)  
Professor of History and the Humanities; Ph.D., Brown University, 1966.

Clark, Mary Morris (1978)  
Professor of English; Ph.D., University of Massachusetts at Amherst, 1978.

Clark, Ronald R. (1987)  
Professor of Electrical Engineering; Ph.D., Syracuse University, 1963.

Cleland, Frances E. (1991)  
Assistant Professor of Physical Education; P.E.D., Indiana University at Bloomington, 1990.

Cohn, Ellen S. (1978)  
Associate Professor of Psychology; Ph.D., Temple University, 1978.

Collins, John J. (1988)  
Assistant Professor of Biochemistry and Molecular Biology and Genetics; Ph.D., University of Wisconsin at Madison, 1984.

Collins, Michael R. (1985)  
Associate Professor of Civil Engineering; Ph.D., University of Arizona, 1985.

Professor of Animal Science; Ph.D., University of Massachusetts at Amherst, 1975.

Condratovich, Russell G. (1991)  
Assistant Professor of Remote Sensing & Geographic Information Systems; Ph.D., Virginia Polytechnic Institute and State University, 1984.

Connors, Robert J. (1984)  
Associate Professor of English; Ph.D., Ohio State University, 1980.

Conway, Karen Smith (1989)  
Associate Professor of Economics; Ph.D., University of North Carolina at Chapel Hill, 1987.

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.

Cote, Rick H. (1988)  
Assistant Professor of Biochemistry and Molecular Biology; 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.

Craycraft, Catherine A. (1991)  
Virginia Paul Dee Assistant Professor of Accounting; Ph.D., Ohio State University, 1991; C.P.A.

Critt, Patrick M. (1988)  
Research Associate Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of North Carolina at Chapel Hill, 1984.

Croce, Ronald C. (1986)  
Associate Professor of Physical Education; Ph.D., University of New Mexico, 1983.

Croker, Robert A. (1966)  
Professor of Environmental History & Conservation; Ph.D., Emory University, 1966.

Crow, Garrett E. (1975)  
Professor of Plant Biology; Ph.D., Michigan State University, 1974.

Curran-Centeno, Joanne (1982)  
Associate Professor of Animal Science and Nutrition; Ph.D., University of Illinois at Urbana-Champaign, 1982.

Darlington, Sidney W. (1971)  
Adjunct Professor of Electrical Engineering; Ph.D., Columbia University, 1940.

Associate Professor of Plant Biology and Genetics; Ph.D., University of California at Davis, 1985.

Dawson, John E. (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, Pillar (1989)  
Assistant Professor of Computer Science; Ph.D., University of Maryland, 1987.

Demitchell, Todd A. (1990)  
Assistant Professor of Education; Ed.D., University of Southern California, 1979.

Dennis, Clyde L. (1982)  
Associate Professor of Biochemistry and Molecular Biology and Genetics; Ph.D., University of Washington, 1982.

Dennman, Margaret-Love G. (1992)  
Assistant Professor of English; M.A., University of Mississippi, 1967.

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.

Research Associate Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., State University of New York at Binghamton, 1988.

Diefendorf, Jeffry M. (1976)  
Professor of History; Ph.D., University of California at Berkeley, 1975.

Dietrich, Susan (1989)  
Assistant Professor of Communication Disorders; Ph.D., University of Oklahoma, 1990.

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, 1964.

Associate Professor of Family and Consumer Studies; Ph.D., Virginia Polytechnic Institute and State University, 1980.

Donnelly, Michael J. (1991)  
Associate Professor of Sociology; Ph.D., University of London, England, 1977.

Associate Professor of Electrical Engineering; Ph.D., Tufts University, 1978.

Dugan-Bedker, Patricia (1985)  
Assistant Professor of Animal Science and Adult Education; Ph.D., Cornell University, 1985.

Duncan, Cynthia M. (1989)  
Associate Professor of Sociology; Ph.D., University of Kentucky, 1985.

Echt, Olot (1990)  
Associate Professor of Physics; Ph.D., University of Konstanz, Germany, 1979.

Eckert, Robert T. (1978)  
Associate Professor of Natural Resources and Genetics; Ph.D., Ohio State University, 1978.
Edwards, Ruth S. (1966)
Associate Professor of Music; M.M.,
Northeastern University, 1950.

Provost and Vice President for Academic
Affairs and Professor of English; Ph.D.,
University of North Carolina at Chapel
Hill, 1971.

Eighmy, T. Taylor (1967)
Director Environmental Research Group
and Research Associate Professor of Civil
Engineering; Ph.D., University of New
Hampshire, 1986.

Elmslie, Bruce T. (1989)
Assistant Professor of Economics; Ph.D.,
University of Utah, 1988.

Engalichev, Nicolas (1963)
Extension Economist, Specialist, Forest
Product Marketing and Utilization and Pro­
fessor of Forest Resources; M.S., S.U.N.Y.
College of Environmental Science and For­
egstry at Syracuse, 1960.

Associate Professor of Economics; Ph.D.,
University of Michigan at Ann Arbor, 1974.

Ernest, John Richard (1993)
Assistant Professor of English; Ph.D., Uni­
versity of Virginia, 1989.

Associate Professor of Music; M.M., New

Estes, George O. (1969)
Professor of Plant Biology; Ph.D., Oregon
State University, 1969.

Ettebari, Ahmad (1980)
Professor of Business Administration;
Ph.D., North Texas State University, 1979.

Evans, Christine V. (1987)
Associate Professor of Pedology; Ph.D.,

Associate Professor of Plant Biology(Cell
Biology); Ph.D., University of South

Fairchild, Thomas P. (1969)
Dean of the College of Life Sciences and
Agriculture, Director of Agricultural Ex­
periment Station and Professor of Animal
Science and Genetics; Ph.D., University of
Wisconsin at Madison, 1964.

Falvey, Janet Elizabeth (1984)
Associate 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)
Professor of Chemical Engineering; Sc.D.,
Massachusetts Institute of Technology,
1976.

Federer, C. Anthony (1970)
Adjunct Professor of Micrometeorology;
Ph.D., University of Wisconsin at Madison,
1964.

Feintuch, Burt H. (1988)
Director of Center for the Humanities and
Professor of English; Ph.D., University of
Hamilton, Lawrence C. (1977)
Associate Professor of Sociology; Ph.D., University of Colorado at Boulder, 1978.

Hanssen, Jan A. (1979)
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.

Hansen, Nancy L. (1982)
Assistant Professor of Marketing; Ph.D., The Union Institute, 1989.

Happgood, 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, Joseph (1980)
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 Professor of Forest Hydrology; Ph.D., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1973.

Hornig, James O. (1966)
Professor of Accounting and Finance; Ph.D., University of Chicago, 1967.

Professor and Chair of Environmental Management and Policy; Ph.D., University of Chicago, 1987.

Hossain, Alireza (1981)
Associate Professor of Mechanical Engineering; Ph.D., North Carolina State University, 1981.

Hoskins, Ronald J. (1988)
Professor of Physics; Ph.D., University of California at Berkeley, 1988.

Horton, Robert D. (1989)
Professor of Soil Chemistry; Ph.D., Purdue University, 1986.

Hosford, John L. (1990)
Associate Professor of Computer Science; Ph.D., University of Pennsylvania, 1990.

Hosler, Donald L. (1981)
Professor of Applied Mathematics; Ph.D., University of California, 1981.

Howell, James L. (1967)
Professor of Mathematics; Ph.D., Brown University, 1967.

Houston, Barbara E. (1991)
Professor of Education; Ph.D., University of Western Ontario, Canada, 1977.

Howard, Charles L. (1969)
Professor of Music; D.M.A., Boston University, 1969.

Professor of Forestry Economics; Ph.D., Oregon State University, 1971.

Howard, W. Hunting (1980)
Associate Professor of Zoology; Ph.D., University of Delaware, 1980.

Hubbard, Colin D. (1967)
Professor of Chemistry; Ph.D., University of Victoria, 1967.

Huck, Romana C. (1988)
Associate Professor of English; Ph.D., University of Notre Dame, 1987.

Ikawa, Miyoshi (1963)
Professor Emeritus of Biochemistry and Adjunct Professor of Zoology; Ph.D., University of Wisconsin at Madison, 1948.

Isenberg, Philip A. (1991)
Research Assistant Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Chicago, 1977.

Jacob, A. Robb (1961)
Professor of Mathematics; Ph.D., University of Chicago, 1946.
Faculty

Jahnke, Leland S. (1977)  
Associate Professor of Plant Biology; Ph.D., University of Minnesota, 1973.

Jansen, Edmund F., Jr. (1969)  
Professor of Resource Economics; Ph.D., North Carolina State University, 1966.

Associate Professor of Animal Science and Nutrition; Ph.D., University of New Hampshire, 1980.

Jerard, Robert (1988)  
Associate Professor of Mechanical Engineering; Ph.D., University of Utah, 1977.

Associate Professor of Nursing; Ed.D., University of Massachusetts at Amherst, 1976.

Assistant Professor of Animal Science; D.V.M., Tufts University, 1985.

Johnson, Richard P. (1979)  
Associate Professor of Family and Consumer Studies; Ed.D., University of Wisconsin at Madison, 1983.

Jones, Carroll J. (1989)  
Professor of Physics; Ph.D., University of California at San Diego, 1981.

Jones, Paul R. (1964)  
Professor of Psychology; Ph.D., Case Western Reserve University, 1967.

Jones, Stephen H. (1985)  
Professor of Animal Sciences; Ph.D., University of California at Berkeley, 1985.

Karson, Marvin J. (1983)  
Professor of Business Statistics and Whittier School Research Professor; Ph.D., North Carolina State University, 1983.

Kaufman, Allen M. (1983)  
Professor of Business Administration; Ph.D., Rutgers, The State University of New Jersey, 1980.

Kaufmann, Richard L. (1963)  
Professor of Physics; Ph.D., Yale University, 1960.

Kayser, John R. (1969)  
Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1969.

Klein, Anita S. (1981)  
Associate Professor of Biochemistry and Molecular Biology; Ph.D., Michigan State University, 1981.

Kletzing, Craig A. (1990)  
Research Assistant Professor of Physical Science; Ph.D., University of California at San Diego, 1989.

Kocher, Thomas D. (1989)  
Associate Professor of Zoology and Genetics; Ph.D., University of California at San Diego, 1986.

Konomchak, Bernadette (1976)  
Associate Professor of Spanish; Ph.D., University of Arizona, 1974.

Kraft, L. Gordon (1978)  
Professor of Electrical Engineering; Ph.D., University of Connecticut, 1977.

Krasner, James (1989)  
Professor of Political Science; Ph.D., University of Pennsylvania, 1989.

Krasnowski, Thomas E. (1985)  
Associate Professor of Mechanical Engineering; Ph.D., Massachusetts Institute of Technology, 1983.

Associate Professor of Education; Ed.D., University of Rochester, 1982.

Kuntz, Aline M. (1988)  
Associate Professor of Political Science; Ph.D., Cornell University, 1987.

Kuo, Shan (1964)  
Professor of Computer Science; D.Eng., Yale University, 1958.

LaCourse, John R. (1980)  
Professor of Electrical Engineering; Ph.D., University of Connecticut, 1981.

LaCroix, Karl A. (1972)  
Interim Dean of the Graduate School and Associate Professor of Medical Laboratory Science; Ph.D., Northeastern University, 1988.

Laird, Jo L. (1991)  
Associate Professor of History; Ph.D., Columbia University, 1969.

Professor of Physics; Ph.D., Harvard University, 1963.

Langan, Richard (1992)  
Adjunct Assistant Professor of Zoology; Ph.D., University of New Hampshire, 1992.

Lauer, David M. (1990)  
Assistant Professor of English; Ph.D., Duke University, 1988.

Larson, David L. (1965)  
Professor of Political Science; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1963.

Laudano, Andrew F. (1986)  
Associate Professor of Biochemistry and Molecular Biology; Ph.D., University of California at San Diego, 1981.

Le, Thomas M. (1984)  
Associate Professor of Biochemistry and Molecular Biology; Ph.D., University of Connecticut, 1981.

Lawson, John H. (1986)  
Interim Director of Affairs Affiliated with Education; Ed.D., Boston University, 1958.

Leak, William B. (1967)  
Adjunct Professor of Natural Resources; Ph.D., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1956.

Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Chicago, 1971.

Associate Professor of Plant Biology; Ph.D., University of Illinois at Urbana-Champaign, 1980.

*Leighton, Charles H. (1956)  
Professor of Spanish and the Humanities; Ph.D., Harvard University, 1961.

Leuchtner, Robert E. (1992)  
Assistant Professor of Physics; Ph.D., Pennsylvania State University, 1990.

Adjunct Professor of Electrical Engineering; Ph.D., Stanford University, 1960.

Lewis, Frederick C. (1976)  
Associate Professor of Communication Disorders; Ph.D., Ohio University, 1970.

Lewis, James B. (1989)  
Assistant Professor of Health Management and Policy; Sc.D., Johns Hopkins University, 1985.

Liebner, Rochelle (1981)  
Professor of English; Ph.D., Massachusetts Institute of Technology, 1980.

Limber, John E. (1971)  
Associate Professor of Political Science; Ph.D., University of Illinois at Urbana-Champaign, 1969.

Limbert, David E. (1969)  
Professor of Mechanical Engineering; Ph.D., Case Western Reserve University, 1969.

Linden, Allen B. (1963)  
Associate Professor of History; Ph.D., Columbia University, 1969.
Lindsay, Bruce E. (1973) Professor of Resource Economics; Ph.D., University of Massachusetts at Amherst, 1976.
Loder, Theodore C., III (1972) Associate Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of Alaska at Fairbanks, 1971.
Lofy, John S. (1991) Assistant Professor of English; Ph.D., Michigan State University, 1986.
Loy, J. Brent (1967) Professor of Plant Biology and Genetics; Ph.D., Colorado State University, 1967.
Lynch, Kathryn R. (1990) Assistant Professor of Nursing; D.N.Sc., Boston University, 1989.
MacHardy, William E. (1972) Extension Plant Pathologist and Professor of Plant Pathology (Plant Pathology); Ph.D., University of Rhode Island, 1970.
Mair, Robert G. (1985) Associate Professor of Psychology; Ph.D., Brown University, 1979.
Malley, James F. (1988) Assistant Professor of Civil Engineering; Ph.D., University of Massachusetts at Amherst, 1988.
Mallory, Bruce L. (1979) Associate Professor of Education; Ph.D., George Peabody College, 1979.
Manalo, Alberto B. (1986) Associate Professor of Resource Economics; Ph.D., Kansas State University, 1986.
Margolin, Aaron B. (1988) Assistant Professor of Microbiology; Ph.D., University of Arizona, 1986.
Mathur, Virendra K. (1974) Professor of Chemical Engineering; Ph.D., University of Missouri at Rolla, 1970.
Mayer, John D. (1989) Associate Professor of Psychology; Ph.D., Case Western Reserve University, 1982.
McBride, Francis D., Jr. (1971) Professor of History; Ph.D., Indiana University at Bloomington, 1967.
McCarthy, Kathleen (1987) Associate Professor of Psychology; Ph.D., Yale University, 1982.
McHugh, John Philip (1986) Associate Professor of Mechanical Engineering; Ph.D., University of Michigan at Ann Arbor, 1986.
Meadows, Dennis (1988) Director of the Institute for Policy and Social Science Research and Professor of Policy Analysis; Ph.D., Massachusetts Institute of Technology, 1969.
Meeber, Carolyn J. (1979) Associate Professor of Psychology; Ph.D., Boston University, 1978.
Melvin, Donald W. (1957) Associate Dean of the College of Engineering and Physical Sciences and Associate Professor of Electrical Engineering; Ph.D., Syracuse University, 1971.
Mennel, Robert M. (1969) Professor of History; Ph.D., Ohio State University, 1969.
Merenda, Michael J. (1977) Associate Professor of Strategic Management; Ph.D., University of Massachusetts at Amherst, 1978.
Miller, John P. (1992) Associate Professor of Physical Education; Ph.D., University of Maryland, 1992.
Miller, W. Thomas, III (1979) Professor of Electrical Engineering; Ph.D., Pennsylvania State University, 1977.
Mitchell, James R. (1964) Extension Agronomist, Forage Crops and Associate Professor of Plant Biology; Ph.D., Pennsylvania State University, 1969.
Mobius, Eberhard (1990) Associate Professor of Physics and Earth, Oceans, and Space; Ph.D., Ruhr-Universitat, Bochum, Germany, 1977.
Moore, Berrien (1965) Director of the Institute for the Study of Earth, Oceans, and Space and Associate Professor of Mathematics and Professor of Earth, Oceans, and Space; Ph.D., University of Virginia, 1969.
Moore, David W. (1972) Professor of Political Science; Ph.D., Ohio State University, 1970.
Morrison, Eileen F. (1990) Assistant Professor of Nursing; Ph.D., University of Arizona, 1986.
Morrison, James D. (1965) Vice President for Research and Public Service and Professor of Chemistry; Ph.D., Northwestern University, 1963.
Mosberg, William (1958) Associate Professor of Mechanical Engineering; M.Eng., Yale University, 1960.
Murdoch, Joseph B. (1952) Professor of Electrical Engineering; Ph.D., Case Western Reserve University, 1962.
Nahin, Paul J. (1975) Associate Professor of Electrical Engineering; Ph.D., University of California at Irvine, 1972.
Naumes, William (1989) Associate Professor of Business Administration; Ph.D., Stanford University, 1971.
Nevin, John A. (1972) Professor of Psychology; Ph.D., Columbia University, 1963.
Newkirk, Thomas R. (1977) Professor of English; Ph.D., University of Texas at Austin, 1977.

Niman, Neil B. (1985)  Associate Professor of Economics; Ph.D., University of Texas at Austin, 1985.


Nitzschke, Dale F. (1990)  President and Professor of Education; Ph.D., Ohio University, 1964.


O'Connell, Lawrence W. (1966)  Associate Professor of Political Science; Ph.D., Syracuse University, 1968.

Oja, Sharon N. (1977)  Associate Professor of Education; Ph.D., University of Minnesota, 1978.

Olson, David P. (1964)  Professor of Wildlife Management; Ph.D., University of Minnesota, 1964.


Osenbruggen, Paul J. (1975)  Associate Professor of Civil Engineering; Ph.D., Carnegie Mellon University, 1970.

Page, Lincoln R. (1984)  Adjunct Professor of Geology; Ph.D., University of Minnesota, 1937.

Palmer, Stuart (1955)  Dean of the College of Liberal Arts and Professor of Sociology; Ph.D., Yale University, 1955.


Pettillo, Juliette D. (1973)  Associate Professor of Nursing; M.S., Boston University, 1973.

Petitgrew, Neal R. (1981)  Adjunct Associate Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1981.

Pilgrim, Sidney A.L. (1979)  Adjunct Professor of Soil Science; B.S., University of New Hampshire, 1955.

Pistole, Thomas G. (1971)  Professor of Microbiology; Ph.D., University of Utah, 1969.

Planalp, Roy Paul (1987)  Associate Professor of Chemistry; Ph.D., University of California at Berkeley, 1983.

Pokoski, John L. (1967)  Professor of Electrical Engineering; Ph.D., Montana State University, 1967.


Polk, Keith (1964)  Professor of Music; Ph.D., University of California at Berkeley, 1968.


Puth, Robert C. (1967)  Professor of Economics; Ph.D., Northwestern University, 1967.

Quinn, Timothy J. (1989)  Assistant Professor of Physical Education; Ph.D., Michigan State University, 1987.

Rasmussen, Mary H. (1968)  Professor of Music; M.L.S., University of Illinois at Urbana-Champaign, 1956.

Reardon, Lawrence (1993)  Assistant Professor of Political Science; Ph.D., Columbia University, 1991.

Reeves, R. Marcel (1964)  Professor of Entomology and Natural Resources; Ph.D., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1964.


Rentschler, Dorothy D. (1990)  Associate Professor of Nursing; Ph.D., New York University, 1986.

Ritos, Roger A. (1987)  Dean of the School of Health and Human Services and Professor of Health Management and Policy; Ph.D., Case Western Reserve University, 1976.

Roberts, John M. (1979)  Extension Specialist, Turf and Associate Professor of Plant Biology; Ph.D., Purdue University, 1977.

Roberts, Lewis, Jr. (1972)  Associate Professor of Occupational Education; Ed.D., Auburn University, 1972.

Robertson, Robert A. (1993)  Assistant Professor of Tourism; Ph.D., University of Illinois at Urbana-Champaign, 1990.
Schwarz, Marc L. (1967)  
Associate Professor of History; Ph.D., University of California at Los Angeles, 1965.  

Schweickart, Patricio P. (1979)  
Professor of English; Ph.D., Ohio State University, 1980.  

Scott, Michelle P. (1990)  
Assistant Professor of Zoology; Ph.D., Harvard University, 1984.  

Professor of Health Management and Policy; M.P.H., Harvard University, 1979.  

Sedgley, Stanley A. (1992)  
Assistant Professor of Economics; Ph.D., University of Michigan at Ann Arbor, 1991.  

Seidel, Lee F. (1977)  
Professor of Health Management and Policy; Ph.D., Pennsylvania State University, 1976.  

Seiler, David E. (1972)  
Professor of Music; M.M., University of Pennsylvania, 1965.  

Seitz, W. Rudolf (1976)  
Professor of Chemistry; Ph.D., Massachusetts Institute of Technology, 1970.  

Selikowitz, Stuart M. (1987)  
Adjunct Associate Professor of Biomedical Engineering; M.D., State University of New York School of Medicine, 1962.  

Sethuraman, Ramachandran (1989)  
Assistant Professor of English; Ph.D., University of Florida, 1990.  

Shepard, Harvey K. (1969)  
Professor of Physics; Ph.D., California Institute of Technology, 1966.  

Sherman, Sarah Way (1984)  
Associate Professor of English; Ph.D., Brown University, 1983.  

Shetty, Sandhya (1988)  
Assistant Professor of English; Ph.D., University of Rochester, 1987.  

Shippee-Rice, Raelene (1979)  
Associate Professor of Nursing; Ph.D., Brandeis University, 1990.  

Shore, Barry (1974)  
Professor of Business Administration; Ph.D., University of Wisconsin at Madison, 1968.  

Shore, Samuel D. (1965)  
Professor of Mathematics; Ph.D., Pennsylvania State University, 1964.  

Short, Frederick T. (1989)  
Research Associate Professor of Natural Resources and Marine Science; Ph.D., University of Alaska at Fairbanks, 1981.  

Siggelakis, Susan J. (1988)  
Assistant Professor of Political Science; Ph.D., Johns Hopkins University, 1988.  

Simic, Charles D. (1973)  
Professor of English; B.A., New York University, 1967.  

Simos, Evangelos O. (1977)  
Professor of Economics; Ph.D., Northern Illinois University, 1977.  

Simpson, Robert E. (1963)  
Professor of Physics; Ph.D., Harvard University, 1960.  

Singh, Anuradha (1993)  
Assistant Professor of Plant Biology; Ph.D., Cornell University, 1988.  

Sir, W. Niel (1970)  
Associate Professor of Music; M.A., University of California at Berkeley, 1962.  

Sitkoff, Harvard (1976)  
Professor of History; Ph.D., Columbia University, 1975.  

Sivaprasad, Kondagunta (1969)  
Professor of Electrical Engineering; Ph.D., Harvard University, 1963.  

Smith, M. Daniel (1967)  
Associate Professor of Education; Ed.D., Harvard University, 1961.  

Smith, Mark R. (1966)  
Professor of English; B.A., Northwestern University, 1960.  

Smith, Patricia B. (1989)  
Assistant Professor of Finance; Ph.D., Graduate School of Business Administration, New York University, 1987.  

Smith, Samuel C. (1961)  
Professor of Animal Science and Biochemistry and Molecular Biology; Ph.D., Pennsylvania State University, 1962.  

Sohl, Jeffrey E. (1983)  
Associate Professor of Business Administration; Ph.D., University of Maryland, 1983.  

Professor of Biochemistry and Molecular Biology; Ph.D., Oregon State University, 1980.  

Spar, T. M. (1989)  
Professor of Computer Science; Ph.D., Texas A & M University, 1972.  

Spear, Margaret W. (1981)  
Associate Professor of Nursing; Ed.D., Vanderbilt University, 1985.  

Spillane, Kathleen Wilson (1986)  
Associate Professor of Music; Ed.D., Columbia University, 1987.  

*Sprague, Linda G. (1969)  

Sproul, Otis J. (1982)  
Dean of the College of Engineering and Physical Sciences and Professor of Civil Engineering; Sc.D., Washington University, 1961.  

Stewart, James A. (1968)  
Associate Dean for Research and Agricultural Experiment Station and Professor of Biochemistry; Ph.D., University of Connecticut, 1967.  

Stibler, Robert (1978)  
Associate Professor of Music; D.M.A., Catholic University of America, 1979.  

Stine, Elizabeth L. (1991)  
Assistant Professor of Psychology; Ph.D., Georgia Institute of Technology, 1983.  

Stine, William (1984)  
Associate Professor of Psychology; Ph.D., Georgia Institute of Technology, 1983.  

Stipetic, Joan D. (1991)  
Assistant Professor of Psychology; Ph.D., Georgia Institute of Technology, 1983.  

Assistant Professor of Finance; Ph.D., Ohio State University, 1988.  

Sundberg, Donald C. (1978)  
Director of Industrial Research and Consulting Center and Associate Professor of Chemical Engineering; Ph.D., University of Delaware, 1970.  

Swift, M. Robinson (1976)  
Associate Professor of Mechanical Engineering and Ocean Engineering; Ph.D., University of New Hampshire, 1974.  

Tagliaferro, Anthony R. (1978)  
Associate Professor of Animal Science and Nutrition; Ph.D., Cornell University, 1978.  

Research Associate Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of Wisconsin at Madison, 1981.  

Taylor, James T. (1977)  
Associate Professor of Zoology; Ph.D., Oregon State University, 1976.  

Associate Professor of Animal Science and Genetics; Ph.D., Mississippi State University, 1981.  

Terry, Clark (1987)  
Adjunct Professor of Music; D.Hum. (Hon.), University of New Hampshire, 1978.  

Thewke, Siegfried E. (1979)  
State Entomologist and Adjunct Associate Professor of Entomology; Ph.D., University of Missouri at Columbia, 1977.  

Associate Professor of Economics and Business Administration; Ph.D., University of Texas at Austin, 1973.  

Tillinghast, Edward K. (1967)  
Professor of Zoology; Ph.D., Duke University, 1966.  

Tischler, Herbert (1965)  
Professor of Geology; Ph.D., University of Michigan at Ann Arbor, 1961.  

Tomellini, Sterling A. (1985)  
Associate Professor of Chemistry; Ph.D., Rutgers, The State University of New Jersey, 1985.  

Torbett, Roy B. (1989)  
Professor of Physics and Earth, Oceans and Space; Ph.D., University of California at Berkeley, 1979.  

Trotz, B. Thomas (1969)  
Professor of Political Science; Ph.D., Indiana University at Bloomington, 1972.  

Trubowitz, Rachel (1986)  
Associate Professor of English; Ph.D., Columbia University, 1985.  

Tsang, Paul C. (1989)  
Assistant Professor of Animal Science; Ph.D., Boston University, 1986.  

Tse, Siu-Kueung (1984)  
Associate Professor of Mathematics; Ph.D., University of Wisconsin at Madison, 1984.  

Tso, Li-ying Hilary (1989)  
Assistant Professor of Family and Consumer Studies; Ph.D., Cornell University, 1991.  

Tucker, James (1992)  
Assistant Professor of Sociology; Ph.D., University of Virginia, 1992.  

Assistant Professor of English; Ph.D., Ohio State University, 1988.  

123
Turner, Elise H. (1990)
Assistant Professor of Computer Science; Ph.D., Georgia Institute of Technology, 1989.

Assistant Professor of Sociology; Ph.D., University of California at San Francisco, 1990.

*Turner, Roy M. (1990)
Research Assistant Professor of Computer Science; Ph.D., Georgia Institute of Technology, 1989.

Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1964.

*Ulrich, Laurel T. (1985)
Professor of History; Ph.D., University of New Hampshire, 1980.

Van Oscho, Donovan H. (1970)
Professor of Mathematics; Ph.D., University of Illinois at Urbana-Champaign, 1969.

Vasudevan, Palligarnai T. (1978)
Assistant Professor of Chemical Engineering; Ph.D., Clarkson University, 1989.

Vagts, Peggy A. (1978)
Associate Professor of Music; M.M., University of Wisconsin at Madison, 1978.

Research Associate 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.

Von Damm, Karen L. (1992)
Associate Professor of Geochemistry; Ph.D., Massachusetts Institute of Technology, 1984.

Vorosmarty, Charles J. (1992)
Research Assistant Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of New Hampshire, 1991.

Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1982.

Wagner, Herbert III (1991)
Assistant Professor of Education; Ed.D., Harvard Graduate School of Education, 1992.

Professor of Zoology; Ph.D., Cornell University, 1976.

Wang, Rosemary Y. (1971)
Associate Professor of Nursing; Ph.D., Boston College, 1982.

Wansart, William L. (1985)
Assistant Professor of Education; Ed.D., University of Northern Colorado, 1984.

Research Assistant Professor of Earth Sciences; Ph.D., University of South Carolina, 1978.

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)
Professor of Zoology; Ph.D., University of Massachusetts at Amherst, 1978.

Watt, David W. (1987)
Associate Professor of Mechanical Engineering; Ph.D., University of Michigan at Ann Arbor, 1987.

Watters, David H. (1978)
Professor of English; Ph.D., Brown University, 1978.

Weatherby, Rita (1978)
Associate Professor of Organizational Behavior; Ed.D., Harvard University, 1977.

Webb, Dwight (1967)
Associate Professor of Education; Ph.D., Stanford University, 1967.

Webber, William R. (1969)
Research 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)
Extension Horticulturist, Vegetables and Professor of Plant Biology; Ph.D., Rutgers, The State University of New Jersey, 1966.

Weyrick, Richard R. (1964)
Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968.

Wheeler, Douglas L. (1965)
Professor of History; Ph.D., Boston University, 1963.

White, Susan O. (1969)
Professor of Political Science; Ph.D., University of Minnesota, 1970.

Associate Professor of Economics; Ph.D., Pennsylvania State University, 1980.

Wicklow, Barry J. (1989)
Adjunct Assistant Professor of Zoology; Ph.D., University of New Hampshire, 1982.

Williams, Daniel C. (1970)
Associate Professor of Psychology; Ph.D., University of California at Santa Barbara, 1970.

Williams-Barnard, Carol L. (1978)
Associate Professor of Nursing; D.N.Sc., Catholic University of America, 1979.

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.

Wood, Craig H. (1990)
Assistant Professor of Operations Management; Ph.D., Ohio State University, 1991.

Associate Professor of Psychology and Adjunct Associate Professor of History; Ph.D., Yale University, 1975.

Wright, John J. (1970)
Professor of Physics; Ph.D., University of New Hampshire, 1969.

Young, Allen J. (1991)
Lead Extension Dairy Specialist and Assistant Professor of Animal Science; Ph.D., Oregon State University, 1987.

Yount, John A. (1962-64,1965)
Professor of English; M.F.A., University of Iowa, 1962.

Zaso, Gus C. (1970)
Associate Professor of Tourism; Re.D., Indiana University at Bloomington, 1965.

Assistant Professor of Chemistry; Ph.D., University of Notre Dame, 1989.

Zia, Lee L. (1985)
Associate Professor of Mathematics; Ph.D., Brown University, 1985.

Zielinski, Gregory A. (1990)
Research Assistant Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., University of Massachusetts at Amherst, 1987.

Zsigay, Robert M. (1970)
Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1969.
**Graduate Calendar 1993–1995**

**1993–1994**

**Semester I**

August 31, Tuesday
8 A.M. Classes begin.
(Classes follow Monday schedule)

September 6, Monday
Labor Day, University offices closed.

September 13, Monday
Last day to register without $25 late registration fee.

September 15–16, Wednesday–Thursday
Rosh Hashanah.*

September 17, 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 choose credit/fail option.

September 25, Saturday
Yom Kippur.*

October 1, Friday
Last day for graduate students to withdraw or drop courses and qualify for ½ tuition refund.
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 15, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (a grade of WP/WF).
Last day to file Intent-to-Graduate form for December graduation without late fee.

November 1, Monday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.

November 2, Tuesday
Election day—no exams can be scheduled.

November 5, Friday
Last day to file Intent-to-Graduate form for December with late fee.

November 11, Thursday
Veterans Day holiday—no classes.

November 24, Wednesday
Last day for Ph.D. dissertation defense (December graduation). Classes follow Thursday schedule.

November 25–26, Thursday–Friday
Thanksgiving holiday—no classes.

November 29, Monday
8 A.M. Classes resume.

December 1, Wednesday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester I, 1993–94.
Last day for completing application for part-time tuition scholarships for Semester II, 1993–94.
Application materials for 1994–95 Dissertation Year Fellowships and 1994 Summer TA Fellowships are available at the Graduate School.

December 10, Friday
Last day of classes.
Last day for resolving incompletes from Semester II, 1992–93, and/or Summer 1993.
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 11, Saturday
Commencement ceremony.

December 13, Monday
Reading Day.

December 14–18, Tuesday–Saturday
Final exams.

**Semester II**

January 12, Wednesday
Last day for submitting application for 1994–95 Dissertation Year Fellowships.

January 17, Monday
Martin Luther King, Jr. holiday—University offices closed.

January 19, Wednesday
8 A.M. Classes begin.

February 1, Tuesday
Last day to register without $25 late registration fee.

February 4, 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 choose credit/fail option.

February 8, Tuesday
Last day for completing application for 1994 Summer TA Fellowships.

February 15, Tuesday
Priority deadline for receipt of FAFSA by the federal processor for application for need-based financial aid for 1994–95 through the Financial Aid Office.
Last day for completing application for admission to graduate study for Semester I, 1994–95, to ensure consideration for financial assistance for the 1994–95 academic year.

February 18, Friday
Last day for graduate students to withdraw or drop courses and qualify for ½ tuition refund.
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 11, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (grade of WP/WF).
Last day to file Intent-to-Graduate form for May graduation without late fee.

March 14–18, Monday–Friday
Spring recess.

---

*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.
March 21, Monday
8 A.M. Classes resume.

March 27, Sunday
Passover.*

April 1, Friday
Good Friday.*
Last day to file Intent-to-Graduate form for May graduation with late fee.
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1994. Recommended deadline for Fall 1994 admission.
Application forms for part-time tuition scholarships for Semester I, 1994–95, are available at the Graduate School.
UNH application forms for summer college work-study available through the Financial Aid Office.

April 3, Sunday
Easter.*

April 27, Wednesday
Last day for final Ph.D. dissertation defense (May graduation).

May 6, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (May graduation).

May 10, Tuesday
Last day of classes.
Last day for resolving incompletes from Semester I, 1993–94.
Last day to take final comprehensive examination for the master's degree (May graduation).

May 11–12, Wednesday–Thursday
Reading Days.

May 13–19, Friday–Thursday
Final exams.

May 21, Saturday
Commencement ceremony.

Summer Session 1994

June 3, Friday
Last day for completing application for part-time tuition scholarships for Semester I, 1994–95.

July 1, Friday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester I, 1994–95.
Last day to file Intent-to-Graduate form for September graduation without late fee.

July 15, Friday
Last day to file for September graduation with late fee.

July 27, Wednesday
Last day for final Ph.D. dissertation defense (September graduation).

August 5, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation).

1994–1995

Semester I

August 30, Tuesday
8 A.M. Classes begin. (Classes follow Monday schedule.)

September 5, Monday
Labor Day—no classes. University offices closed.

September 5–6, Monday–Tuesday
Rosh Hashanah.*

September 12, Monday
Last day to register without $25 late registration fee.

September 15, Thursday
Yom Kippur.*

September 16, 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 choose credit/fail option.

September 30, Friday
Last day for graduate students to withdraw or drop courses and qualify for $1/2 tuition refund.
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 14, Friday
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (a grade of WP/WF).
Last day to file Intent-to-Graduate form for December graduation without late fee.

November 1, Tuesday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.

November 4, Friday
Last day to file for December graduation without late fee.

November 8, Tuesday
Election Day—no exams can be scheduled.

November 11, Friday
Veterans Day holiday observed—no classes.

November 23, Wednesday
Last day for Ph.D. dissertation defense (December graduation). Classes hold Friday schedule.

November 24–25, Thursday–Friday
Thanksgiving holiday—no classes.

November 28, Monday
8 A.M. Classes resume.

December 1, Thursday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester II, 1994–95.
Last day for completing application for part-time tuition scholarships for Semester II, 1994–95.
Application materials for 1995–96 Dissertation Year Fellowships and 1995 Summer TA Fellowships are available at the Graduate School.

December 9, Friday
Last day of classes.
Last day for resolving incompletes from Semester II, 1993–94, and/or Summer 1994.
Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (December graduation).
Last day to take final comprehensive examination for the master's degree.

**December 12, Monday**
Reading Day.

**December 13–17, Tuesday–Saturday**
Final exams.

**December 31, Saturday**
Graduation. (No commencement ceremony.)

**Semester II**

**January 11, Wednesday**
Last day for submitting application for 1995–96 Dissertation Year Fellowship.

**January 16, Monday**
Martin Luther King, Jr. holiday—University offices closed.

**January 18, Wednesday**
8 A.M. Classes begin.

**January 31, Tuesday**
Last day to register without $25 late registration fee.

**February 3, 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 choose credit/fail option.

**February 7, Tuesday**
Last day for completing application for 1995 Summer TA Fellowships.

**February 15, Wednesday**
Last day for completing application for admission to graduate study for Semester I, 1995–96, to ensure consideration for financial assistance for the 1995–96 academic year.
Priority deadline for receipt of FAFSA by the federal processor for application for need-based financial aid for 1995–96 through the Financial Aid Office.

**February 17, Friday**
Last day to withdraw or drop courses and qualify for $1/2 tuition refund.
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 10, Friday**
Midsemester.
Last day to drop courses or withdraw from the University without academic liability (grade of WP/WF).
Last day to file Intent-to-Graduate form for May graduation without late fee.

**March 13–17, Monday–Friday**
Spring recess.

**March 20, Monday**
8 A.M. Classes resume.

**March 31, Friday**
Last day to file for May graduation with late fee.

**April 3, Monday**
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1995.
Recommended deadline for Fall 1995 admission.
Application forms for part-time tuition scholarships for Semester I, 1995–96 are available at the Graduate School.
UNH application forms for summer college work-study available from the Financial Aid Office.

**April 14, Friday**
Good Friday.*

**April 15, Saturday**
Passover.*

**April 16, Sunday**
Easter.*

**April 26, Wednesday**
Last day for final Ph.D. dissertation defense (May graduation).

**May 5, 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 9, Tuesday**
Last day of classes.
Last day for resolving incompletes from Semester I, 1994–95.

**May 10–11, Wednesday–Thursday**
Reading Days.

**May 12–18, Friday–Thursday**
Final exams.

**May 20, Saturday**
Commencement ceremony.

**Summer Session 1995**

**June 2, Friday**
Last day for completing application for part-time tuition scholarships for Semester I, 1995–96.

**June 30, Friday**
Last day to file Intent-to-Graduate form for September graduation without late fee.

**July 3, Monday**
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester I, 1995–96.

**July 14, Friday**
Last day to file Intent-to-Graduate form for September graduation with late fee.

**July 26, Wednesday**
Last day for final Ph.D. dissertation defense (September graduation).

**August 4, Friday**
Last day for presenting final copies of doctoral dissertation or master’s thesis to the Graduate School for binding (September graduation).
### Index

<table>
<thead>
<tr>
<th>Subject</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic regulations</td>
<td>19</td>
</tr>
<tr>
<td>Academic standards</td>
<td>19</td>
</tr>
<tr>
<td>ACCESS</td>
<td>33</td>
</tr>
<tr>
<td>Administration and supervision. See Education.</td>
<td></td>
</tr>
<tr>
<td>Administrative officers</td>
<td>115</td>
</tr>
<tr>
<td>Administrative withdrawal</td>
<td>11</td>
</tr>
<tr>
<td>Admission</td>
<td>7-8</td>
</tr>
<tr>
<td>Agricultural Experiment Station</td>
<td>23</td>
</tr>
<tr>
<td>Animal and nutritional sciences</td>
<td>34</td>
</tr>
<tr>
<td>Application procedures</td>
<td>7</td>
</tr>
<tr>
<td>Assistantships</td>
<td>16-17</td>
</tr>
<tr>
<td>Auditing</td>
<td>9</td>
</tr>
<tr>
<td>Bachelor's degree/M.B.A.</td>
<td>8</td>
</tr>
<tr>
<td>Biochemistry</td>
<td>36</td>
</tr>
<tr>
<td>Biogeochemical Systems Center</td>
<td>23</td>
</tr>
<tr>
<td>Biology</td>
<td>37</td>
</tr>
<tr>
<td>Business administration</td>
<td>37</td>
</tr>
<tr>
<td>Calendar, academic</td>
<td>125</td>
</tr>
<tr>
<td>Career Services</td>
<td>33</td>
</tr>
<tr>
<td>Center for Business and Economics Research</td>
<td>26</td>
</tr>
<tr>
<td>Center for the Humanities</td>
<td>26-27</td>
</tr>
<tr>
<td>Center for Ocean Sciences</td>
<td>26</td>
</tr>
<tr>
<td>Center for Venture Research</td>
<td>27</td>
</tr>
<tr>
<td>Cert. of Advanced Graduate Study</td>
<td>21</td>
</tr>
<tr>
<td>Change in degree</td>
<td>11</td>
</tr>
<tr>
<td>Chemical engineering</td>
<td>41</td>
</tr>
<tr>
<td>Chemistry</td>
<td>42</td>
</tr>
<tr>
<td>Civil engineering</td>
<td>44</td>
</tr>
<tr>
<td>Communication disorders</td>
<td>46</td>
</tr>
<tr>
<td>Complex Systems Research Center</td>
<td>23</td>
</tr>
<tr>
<td>Computer science</td>
<td>48</td>
</tr>
<tr>
<td>Computing and Information Services</td>
<td>29-30</td>
</tr>
<tr>
<td>Counseling. See Education</td>
<td></td>
</tr>
<tr>
<td>Counseling Center</td>
<td>32-33</td>
</tr>
<tr>
<td>Course descriptions</td>
<td>34</td>
</tr>
<tr>
<td>Degree requirements</td>
<td>19-22</td>
</tr>
<tr>
<td>Differential tuition</td>
<td>15</td>
</tr>
<tr>
<td>Dining</td>
<td>31</td>
</tr>
<tr>
<td>Disabilities, services for students with ACCESS</td>
<td></td>
</tr>
<tr>
<td>Doctoral degree requirements</td>
<td>21-22</td>
</tr>
<tr>
<td>Doctoral programs</td>
<td>5</td>
</tr>
<tr>
<td>(See also specific departments.)</td>
<td></td>
</tr>
<tr>
<td>Dual credit</td>
<td>20</td>
</tr>
<tr>
<td>Early admission/UNH seniors</td>
<td>8</td>
</tr>
<tr>
<td>Early childhood education</td>
<td></td>
</tr>
<tr>
<td>See Education</td>
<td></td>
</tr>
<tr>
<td>Earth sciences</td>
<td>51</td>
</tr>
<tr>
<td>Economics</td>
<td>54</td>
</tr>
<tr>
<td>Education</td>
<td>56</td>
</tr>
<tr>
<td>Electrical and computer engineering</td>
<td>65</td>
</tr>
<tr>
<td>Elementary education. See Education. Engineering Ph.D. program</td>
<td>67</td>
</tr>
<tr>
<td>English</td>
<td>68</td>
</tr>
<tr>
<td>Entomology</td>
<td>72</td>
</tr>
<tr>
<td>Environmental Research Group</td>
<td>27</td>
</tr>
<tr>
<td>Facilities and Services</td>
<td>30-33</td>
</tr>
<tr>
<td>Faculty</td>
<td>116</td>
</tr>
<tr>
<td>Family and consumer studies</td>
<td>73</td>
</tr>
<tr>
<td>Family Research Laboratory</td>
<td>27</td>
</tr>
<tr>
<td>Fees</td>
<td>13-15</td>
</tr>
<tr>
<td>Fellowships</td>
<td>16</td>
</tr>
<tr>
<td>Financial Aid</td>
<td>15-17</td>
</tr>
<tr>
<td>Forestry. See Natural Resources.</td>
<td></td>
</tr>
<tr>
<td>Genetics</td>
<td>75</td>
</tr>
<tr>
<td>Geology. See Earth sciences.</td>
<td></td>
</tr>
<tr>
<td>Glacier Research Group</td>
<td>23-25</td>
</tr>
<tr>
<td>Grades</td>
<td>19</td>
</tr>
<tr>
<td>Graduate Council</td>
<td>115</td>
</tr>
<tr>
<td>Graduate programs</td>
<td>3</td>
</tr>
<tr>
<td>Graduation</td>
<td>22</td>
</tr>
<tr>
<td>Handicapped, services for Access.</td>
<td></td>
</tr>
<tr>
<td>Health Services</td>
<td>32</td>
</tr>
<tr>
<td>Health Administration</td>
<td>76</td>
</tr>
<tr>
<td>History</td>
<td>78</td>
</tr>
<tr>
<td>Honorary fellows</td>
<td>8</td>
</tr>
<tr>
<td>Housing</td>
<td>30-31</td>
</tr>
<tr>
<td>Hydrology. See Earth sciences.</td>
<td></td>
</tr>
<tr>
<td>Incompletes</td>
<td>19</td>
</tr>
<tr>
<td>Institute for Policy and Social Science Research</td>
<td>27</td>
</tr>
<tr>
<td>Institute for the Study of Earth, Oceans, and Space (EOS)</td>
<td>23, 50</td>
</tr>
<tr>
<td>Institute on Disability</td>
<td>27</td>
</tr>
<tr>
<td>Insurance, accident and sickness</td>
<td>15</td>
</tr>
<tr>
<td>Intercollege cooperative programs. See Natural Resources.</td>
<td></td>
</tr>
<tr>
<td>Interdisciplinary programs</td>
<td>5</td>
</tr>
<tr>
<td>International Students' Office</td>
<td>33</td>
</tr>
<tr>
<td>Language and linguistics. See English.</td>
<td></td>
</tr>
<tr>
<td>Leave of absence</td>
<td>11</td>
</tr>
<tr>
<td>Library</td>
<td>29</td>
</tr>
<tr>
<td>Literature. See English.</td>
<td></td>
</tr>
<tr>
<td>Loans</td>
<td>17</td>
</tr>
<tr>
<td>Marine program</td>
<td>25-26</td>
</tr>
<tr>
<td>Marriage and family therapy.</td>
<td></td>
</tr>
<tr>
<td>See Family and consumer studies.</td>
<td></td>
</tr>
<tr>
<td>Master's continuing enrollment</td>
<td>81</td>
</tr>
<tr>
<td>Master's degree requirements</td>
<td>21</td>
</tr>
<tr>
<td>Master's programs</td>
<td>5</td>
</tr>
<tr>
<td>(See also specific departments.)</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>81</td>
</tr>
<tr>
<td>Mechanical engineering</td>
<td>84</td>
</tr>
<tr>
<td>Microbiology</td>
<td>86</td>
</tr>
<tr>
<td>Music</td>
<td>88</td>
</tr>
<tr>
<td>Music education</td>
<td>90</td>
</tr>
<tr>
<td>Natural Resources</td>
<td>90</td>
</tr>
<tr>
<td>Natural Resources Ph.D. Program</td>
<td>93</td>
</tr>
<tr>
<td>New England Regional Student</td>
<td></td>
</tr>
<tr>
<td>Program</td>
<td>13</td>
</tr>
<tr>
<td>Nursing</td>
<td>94</td>
</tr>
<tr>
<td>Occupational education</td>
<td>96</td>
</tr>
<tr>
<td>Ocean engineering</td>
<td>97</td>
</tr>
<tr>
<td>Ocean Process Analysis Laboratory. See Earth sciences.</td>
<td></td>
</tr>
<tr>
<td>Oceanography. See Earth sciences.</td>
<td></td>
</tr>
<tr>
<td>Off-campus courses</td>
<td>20-21</td>
</tr>
<tr>
<td>Organizations</td>
<td>30</td>
</tr>
<tr>
<td>Physical education</td>
<td>98</td>
</tr>
<tr>
<td>Physics</td>
<td>99</td>
</tr>
<tr>
<td>Plant biology</td>
<td>101</td>
</tr>
<tr>
<td>Political science</td>
<td>103</td>
</tr>
<tr>
<td>Psychology</td>
<td>105</td>
</tr>
<tr>
<td>Public administration</td>
<td>104</td>
</tr>
<tr>
<td>Reading. See Education.</td>
<td></td>
</tr>
<tr>
<td>Reading and writing instruction. See Education.</td>
<td></td>
</tr>
<tr>
<td>Readmission</td>
<td>11</td>
</tr>
<tr>
<td>Recreational facilities</td>
<td>31</td>
</tr>
<tr>
<td>Refunds</td>
<td>15</td>
</tr>
<tr>
<td>Registration</td>
<td>8-11</td>
</tr>
<tr>
<td>Research</td>
<td>23</td>
</tr>
<tr>
<td>Residency status</td>
<td>13</td>
</tr>
<tr>
<td>Resource administration and management</td>
<td>107</td>
</tr>
<tr>
<td>Resource economics</td>
<td>107</td>
</tr>
<tr>
<td>Scholarships</td>
<td>16</td>
</tr>
<tr>
<td>Secondary education. See Education.</td>
<td></td>
</tr>
<tr>
<td>Senior citizens</td>
<td>15</td>
</tr>
<tr>
<td>Sociology</td>
<td>108</td>
</tr>
<tr>
<td>Soil science. See Natural Resources.</td>
<td></td>
</tr>
<tr>
<td>Space Science Center</td>
<td>25</td>
</tr>
<tr>
<td>Spanish</td>
<td>111</td>
</tr>
<tr>
<td>Special education. See Education.</td>
<td></td>
</tr>
<tr>
<td>Special needs. See Education.</td>
<td></td>
</tr>
<tr>
<td>Special students</td>
<td>8</td>
</tr>
<tr>
<td>Special-credit rule</td>
<td>20</td>
</tr>
<tr>
<td>Sub-Degree Exchange Program</td>
<td>13</td>
</tr>
<tr>
<td>Summer assistantships and fellowships</td>
<td>17</td>
</tr>
<tr>
<td>Summer Session</td>
<td>9</td>
</tr>
<tr>
<td>Teacher education. See Education.</td>
<td></td>
</tr>
<tr>
<td>Transfer credits</td>
<td>20</td>
</tr>
<tr>
<td>Trustees</td>
<td>115</td>
</tr>
<tr>
<td>Tuition</td>
<td>13-15</td>
</tr>
<tr>
<td>University history</td>
<td>5</td>
</tr>
<tr>
<td>Water Resource Research Center</td>
<td>27</td>
</tr>
<tr>
<td>Wildlife. See Natural Resources.</td>
<td></td>
</tr>
<tr>
<td>Withdrawal</td>
<td>11</td>
</tr>
<tr>
<td>Woman's Commission</td>
<td>33</td>
</tr>
<tr>
<td>Work study</td>
<td>17</td>
</tr>
<tr>
<td>Writing. See English.</td>
<td></td>
</tr>
<tr>
<td>Writing Process Laboratory</td>
<td>27</td>
</tr>
<tr>
<td>Zoology</td>
<td>112</td>
</tr>
</tbody>
</table>