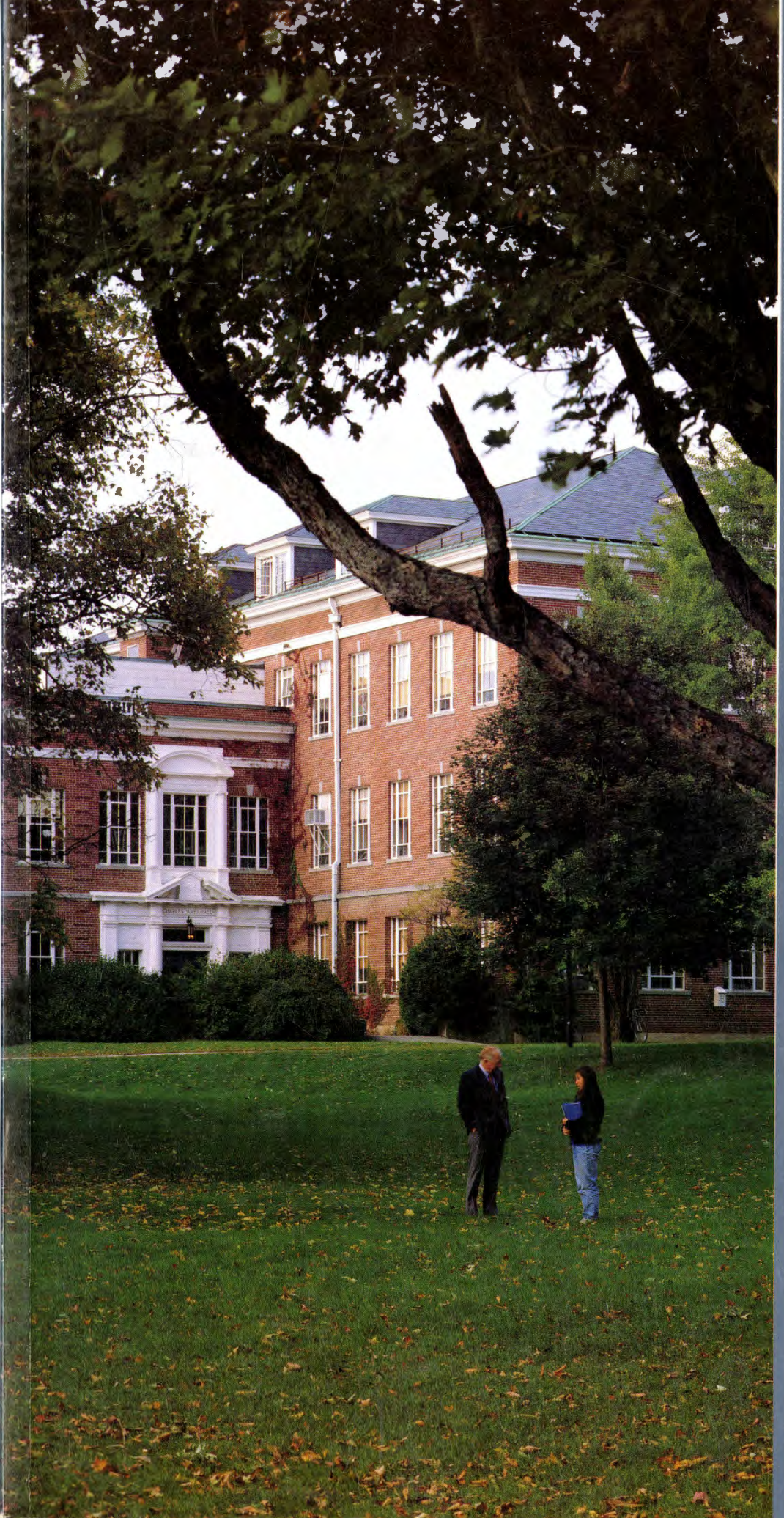

Bulletin of the

UNIVERSITY OF NEW HAMPSHIRE

Graduate Catalog 1991–1993

UNIVERSITY OF
NEW HAMPSHIRE

Graduate Catalog
1991 – 1993

Graduate Calendar 1991–1993

1991–1992

Semester I

September 4, Wednesday
8 A.M. Classes begin.
(Hold Monday schedule)

September 9–10, Monday–Tuesday
Rosh Hashanah.**

September 11–12, Wednesday–Thursday
September 16–17, Monday–Thursday
Graduate student registration.

September 17, Tuesday
Last day to register without $25 late registration fee.

September 18, Wednesday
Yom Kippur.**
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

September 20, 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.

October 4, 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 18, 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, Friday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.
Last day to file for December graduation with late fee.

November 5, Tuesday
Election day—no exams can be scheduled.

November 11, Monday
Veterans Day holiday observed—no classes.

November 27, Wednesday
Last day for Ph.D. dissertation defense (December graduation).

November 28–29, Thursday–Friday
Thanksgiving holiday—no classes.

December 2, Monday
8 A.M. Classes resume.
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester II, 1991–92.
Last day for completing application for part-time tuition scholarships for Semester II, 1991–92.
Application materials for 1992–93 Dissertation Year Fellowships and 1992 Summer TA Fellowships are available at the Graduate School.
FAF forms for 1992–93 need-based financial aid available in Financial Assistance Center, Stoke.

December 6, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (December graduation).
Last day to take final comprehensive examination for the master's degree.

December 13, Friday
Last day of classes.
Last day for resolving incompletes from Semester II, 1990–91, and/or Summer 1991.

December 14, Saturday
Commencement.

December 16, Monday
Reading Day.

December 17–21, Tuesday–Saturday
Final exams.

Semester II

January 15, Wednesday
Last day for submitting application for 1992–93 Dissertation Year Fellowships.

January 20, Monday
Martin Luther King, Jr.'s birthday observed.

January 22, Wednesday
8 A.M. Classes begin.

January 29–30, Wednesday–Thursday
Graduate student registration.

February 3–4, Monday–Tuesday
Graduate student registration.

February 4, Tuesday
Last day to register without $25 late registration fee.

February 5, Wednesday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

February 7, 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 11, Tuesday
Last day for completing application for 1992 Summer TA Fellowships.

February 14, Friday
Last day for completing application for admission to graduate study for Semester I, 1992–93, to ensure consideration for financial assistance for the 1992–93 academic year.
Priority deadline for receipt of FAF in Princeton, NJ, for application for need-based financial aid for 1992–93 through the Financial Assistance Center, Stoke.

February 21, 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.

March 13, 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 16–20, Monday–Friday
Spring recess.

March 23, Monday
8 A.M. Classes resume.

April 1, Wednesday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1992.
Recommended deadline for Fall 1992 admission.
Application forms for part-time tuition scholarships for Semester I, 1992–93, are available at the Graduate School.

**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.*

UNH application forms for summer college work study available through Financial Assistance Center, Stoke.
Last day to file for May graduation with late fee.

April 17, Friday
Good Friday.**

April 18, Tuesday
Passover.**

April 19, Sunday
Easter.

April 29, Wednesday
Last day for final Ph.D. dissertation defense (May graduation).

May 8, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (May graduation).
Last day to take final comprehensive examination for the master's degree.

May 12, Tuesday
Last day of classes.
Last day for resolving incompletes from Semester I, 1991–92.

May 13–14, Wednesday–Thursday
Reading days.

May 15–21, Friday–Thursday
Semester II final exams.

May 23, Saturday
Commencement.

Summer Session 1992

June 5, Friday
Last day for completing application for part-time tuition scholarships for Semester I, 1992–93.

July 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, 1992–93.
Last day to file Intent-to-Graduate form for September graduation without late fee.

July 15, Wednesday
Last day to file for September graduation with late fee.

July 29, Wednesday
Last day for final Ph.D. dissertation defense (September graduation).

August 7, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation).

1992–1993

Semester I

September 1, Tuesday
8 A.M. Classes begin.

September 7, Monday
Labor Day—no classes.

September 9–10, Wednesday–Thursday
September 14–15, Monday–Tuesday
Graduate student registration.

September 15, Tuesday
Last day to register without $25 late registration fee.

September 16, Wednesday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

September 18, 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 28–29, Monday–Tuesday
Rosh Hashanah.**

October 2, 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 7, Wednesday
Yom Kippur.**

October 16, 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 3, Tuesday
Election Day—no exams can be scheduled.

November 6, Friday
Application forms for part-time tuition scholarships for Semester II are available at the Graduate School.
Last day to file for December graduation with late fee.

November 11, Wednesday
Veterans Day holiday observed—no classes.

November 25, Wednesday
Last day for Ph.D. dissertation defense (December graduation).

November 26–27, Thursday–Friday
Thanksgiving holiday—no classes.

November 30, Monday
8 A.M. Classes resume.

December 1, Tuesday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Semester II, 1992–93.
Last day for completing application for part-time tuition scholarships for Semester II, 1992–93.
Application materials for 1993–94 Dissertation Year Fellowships and 1993 Summer TA Fellowships are available at the Graduate School.
FAF forms for 1993–94 need-based financial aid available in Financial Assistance Center, Stoke Hall.

December 4, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (December graduation).
Last day to take final comprehensive examination for the master's degree.

December 11, Friday
Last day of classes.
Last day for resolving incompletes from Semester II, 1991–92, and/or Summer 1992.

December 12, Saturday
Commencement.

December 14, Monday
Reading Day.

December 15–19, Tuesday–Saturday
Final exams.

Semester II

January 15, Friday
Last day for submitting application for 1993–94 Dissertation Year Fellowship.

January 18, Monday
Martin Luther King, Jr.'s birthday observed.

January 20, Wednesday
8 A.M. Classes begin.

January 27–28, Wednesday–Thursday
Graduate student registration.

February 1–2, Monday–Tuesday
Graduate student registration.

February 2, Tuesday
Last day to register without $25 late registration fee.

February 3, Wednesday
Last day for graduate students to withdraw or drop courses and qualify for 3/4 tuition refund.

February 5, 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 9, Tuesday
Last day for completing application for 1993 Summer TA Fellowships.

February 15, Monday
Last day for completing application for admission to graduate study for Semester I 1993–94, to ensure consideration for financial assistance for the 1993–94 academic year.
Priority deadline for receipt of FAF in Princeton for application for need-based financial aid for 1993–94 through the Financial Assistance Center, Stoke.

February 19, 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 12, 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 15–19, Monday–Friday
Spring recess.

March 22, Monday
8 A.M. Classes resume.

April 1, Thursday
Last day for completing application for admission to graduate study, request for change in degree program, or application for readmission for Summer Session 1993.
Recommended deadline for Fall 1993 admission.
Application forms for part-time tuition scholarships for Semester I, 1993–94 are available at the Graduate School.
UNH application forms for summer college work-study available from Financial Assistance Center, Stoke Hall.
Last day to file for May graduation with late fee.

April 6, Saturday
Passover.**

April 9, Friday
Good Friday.**

April 11, Sunday
Easter.**

April 28, Wednesday
Last day for final Ph.D. dissertation defense (May graduation).

May 7, 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 11, Tuesday
Last day of classes.
Last day for resolving incompletes from Semester I, 1992–93.

May 12–13, Wednesday–Thursday
Reading days.

May 14–20, Friday–Thursday
Semester II final exams.

May 22, Saturday
Commencement.

Summer Session 1993

June 4, Friday
Last day for completing application for part-time tuition scholarships for Semester I, 1993–94.

July 2, Friday
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 to file Intent-to-Graduate form for September graduation without late fee.

July 16, Friday
Last day to file Intent-to-Graduate form for September graduation with late fee.

July 28, Wednesday
Last day for final Ph.D. dissertation defense (September graduation).

August 6, Friday
Last day for presenting final copies of doctoral dissertation or master's thesis to the Graduate School for binding (September graduation).

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Contents

Graduate Programs

"As a foreign student, I'm very interested in people who come to the U.S. The education they receive does not help them understand the culture. There are people who have been in this country for years who have no understanding at all of what the culture is about. There are some things education cannot do. There are times when education separates people from life.

"When I was an English professor in China at Nanking University, I found that my students would study the language and learn all the grammar and punctuation but never learn the meanings behind the words. They disconnected the language from meaning because we stressed too much learning the language and not what language is for. I talked to many American educators about my frustration and they suggested that I come to UNH and study with Don Graves. They said if this is what I wanted to study, then I should be studying at UNH.

"In my studies with Jane Hansen and Don Graves, I'm learning how to reverse the process—how we can teach what language conveys before we overstress memorization. I look forward to the time when I can take back what I've learned in this program to China. Encouraging the people to question the rules. That's what our country needs—to help turn people's thinking around. We can help them learn to ask: what is language for?"

Dan-Ling Fu
Ph.D. student
Reading and Writing Program

Master of Arts
Counseling
Economics
English
- Literature
- Language and Linguistics
- Writing

History
Music
Political Science
Psychology
Sociology
Spanish

Master of Science
Animal and Nutritional Sciences
Biochemistry
Biology
Chemical Engineering
Chemistry
Civil Engineering
Communication Disorders
Computer Science
Earth Sciences
- Geology
- Oceanography

Electrical Engineering
Entomology
Family and Consumer Studies
- Marriage and Family Therapy

Forestry
Genetics
Hydrology
Mathematics
Mechanical Engineering
Microbiology
Music Education
Nursing
Ocean Engineering
Physical Education
Physics
Plant Biology
Resource Administration and Management
Resource Economics
Soil Science
Wildlife
Zoology

Master of Arts in Teaching
Elementary Education
Secondary Education

Master of Education
Administration and Supervision
Counseling
Early Childhood Education
- Special Needs

Elementary Education
Reading
Secondary Education
Special Education

Master of Science for Teachers
Chemistry
English
Mathematics
Physics

Master of Occupational Education

Master of Business Administration

Master of 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

In 1882, it was doubtful that anyone—beyond Benjamin Thompson's lawyer and his housekeeper—was aware of what the wealthy Durham farmer's will contained. With the exception of a few small bequests, Thompson willed his entire estate to the state of New Hampshire with the stipulation that, 20 years after his death, the state would establish: "... an agricultural school, to be located on my Warner farm, so-called, and situated in Durham, wherein shall be thoroughly taught, both in the schoolroom and in the field, the theory and practice of that most useful and honorable calling."

(excerpted from History of the University of New Hampshire, 1866–1941*)*

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 School for Lifelong Learning.

The University enrolls more than 10,000 students, has a full-time faculty of about 600, and offers 95 undergraduate and 77 graduate programs. The student body includes more than 1,300 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 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.

"One of the best features of the Actimeter suit project is that graduate students get involved in concerns (such as occupational therapy, neurophysiology, and computer engineering) that go way beyond typical electrical engineering. They work on a tool for observing other people's mobility and range of motion and, by doing so, help modify jobs to suit differently abled folks and help them get a job. That's what it's all about: job placement and assessment."

John LaCourse
Professor of Electrical Engineering

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.

Applying for Admission

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

Application procedures are included with the application materials, which are available from the Graduate School, University of New Hampshire, Thompson Hall, Durham, N.H. 03824-1497. Specific program information and admission and degree requirements are outlined in the program descriptions of this catalog. The completed application for admission to graduate study also serves as the application (for new students) for assistantships and for full-time scholarships supported through the Graduate School.

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

Applicants for admission must

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

An application will be reviewed when the file is complete. It is the applicant's responsibility to make sure that the required application materials have been submitted.

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

Applicants from Foreign Countries

All applicants from non-English-speaking countries must, in addition to all of the above, provide TOEFL (Test of English as a Foreign Language) scores. A minimum TOEFL score of 550 is required 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 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 until 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 26.)

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, 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 Graduate Center, or the School 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 26.)

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

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

Registration

Academic Year

Students admitted to the Graduate School must have their programs approved by their adviser or the chairperson of their guidance committees. Registration is usually held during the second week of classes. All tuition and fees are payable at the time of registration. Registration information and the *Time and Room Schedule* may be obtained from the Registrar's Office 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

"What started me toward a career in history was a course I took with Charles Clark (that's still being offered) called The Historical and Descriptive Literature of Early America. In this course, we studied primary materials (those written by contemporaries) of the 18th century. I felt very comfortable with Clark's approach to history. It was significant that he thought of himself as a writer—he has a journalism background—and that he didn't distinguish between being an academic scholar and writing for a wider audience.

"From the other side of the desk now, I love teaching graduate students. It's important to me to be more than a 'consumer' of other people's work—to work toward contributing to the field. As a teacher of graduate students, I am able to help other young scholars find their way to primary research—much as Charles Clark once helped me. One of the things I find very exciting about the history department at UNH is that we bring people together from such a variety of backgrounds. I have students with backgrounds in computer science, journalism, historical archaeology, sociology, and theology. It's a wonderful mix of people. A significant number of the students are older, coming to UNH after many years in other fields. We even have one student who has a background in nuclear engineering. But history is a very broad field: everything has a history. And here at UNH, it's enriched by graduate students who provide new perspectives and experiences to the subject."

Laurel Ulrich
Professor of History
Ph.D., 1980
University of New Hampshire

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 twelve 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.

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

Nonregistration

Leave of Absence Students who find it necessary to interrupt their graduate programs may request a leave of absence by writing to the dean of the Graduate School stating the reasons for, and the anticipated length of, the interruption. Leaves are granted for a specific time, usually not to exceed one calendar year, 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.

"The main reason I came to WSBE was because of its reputation: strong but small, a place where each student would have ample opportunity to interact with other students and the faculty. There are 30 to 35 students in each class compared to other schools which have hundreds in the same class. Studying at Whittemore also provides greater opportunity for employment in this region—employers are looking for WSBE graduates. A couple of years ago I saw WSBE listed in U.S. News and World Report *as an 'up and coming regional business school' and that, too, piqued my interest.*

"I have had some management experience and a great deal of legal experience, and I felt an M.B.A. would also give me a solid business background. That it would open more doors. Since then, my study at UNH has refocused my direction. Until I took Financial Management, I hadn't thought about finance before. Now I want to learn all I can about the subject. Also, with my liberal arts background, I thought I would be at a disadvantage. Yet the students here come from a wide variety of backgrounds. The collective experience they bring to the group is fabulous. The classes all involve a lot of give and take—there's not much in the way of straight lecturing. You learn a lot more with the give and take approach."

John Tilly
M.B.A. student
Whittemore School of Business and Economics

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

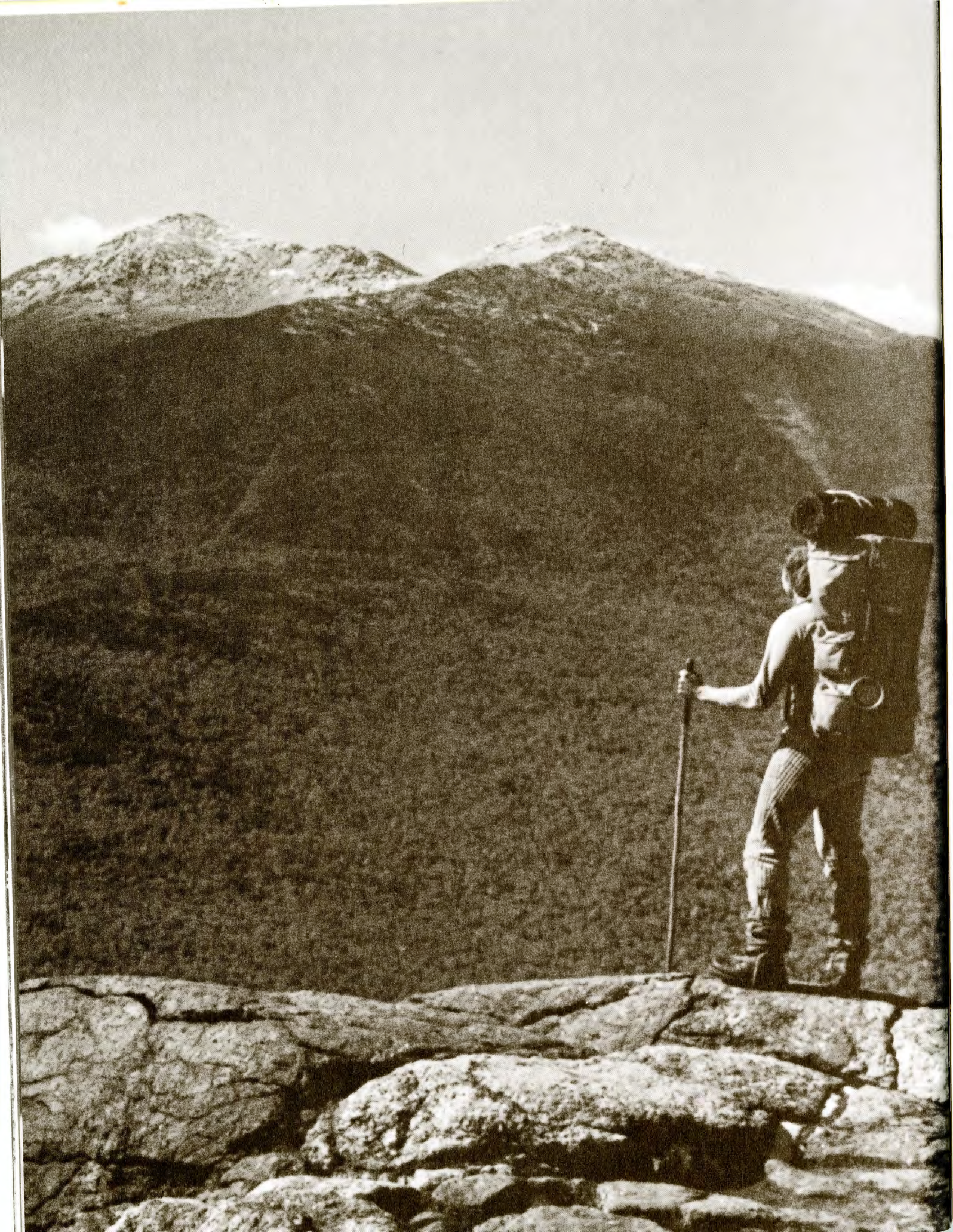
Readmission

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

Change in Degree

An enrolled student who wishes to pursue a degree program other than the one for which admission was granted originally 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.



The University of New Hampshire is located in Durham, in the seacoast region of the state. Outdoor enthusiasts will find that Durham is within a 20 minutes' drive of the ocean, an hour's drive of the lakes region, and two hours' drive of the White Mountains.

Residency

Each graduate student is classified as a resident or nonresident for tuition purposes at the time of admission to the University. The decision, made by the Graduate School, is based upon information furnished by the student's application and any other relevant information. Nonresident undergraduates continuing directly to the Graduate School will be classified as nonresidents.

All applicants claiming New Hampshire residency are required to have been legally domiciled in New Hampshire continuously for at least twelve months immediately prior to registering for the term for which in-state status is claimed.

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

The burden of proof in all cases is upon the applicant. In all cases, the University reserves the right to make the final decision as to resident status for tuition purposes. The University rules governing tuition rates are fully set forth in the application for admission package; all students are bound by them. Forms are available at the Registrar's Office, Stoke Hall.

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, Thompson Hall, UNH, Durham, NH 03824-1497, 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, Thompson Hall, UNH, Durham, NH 03824-1497.

Schedule of Tuition and Fees

The following schedule of tuition and fees is in effect each semester of the 1991–92 academic year, and is subject to change for 1992–93. 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 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. These charges will apply to admitted graduate students enrolling for courses at the University during the academic year. Admitted graduate students planning to enroll for UNH courses off campus or during the summer session should consult the relevant publications for information regarding tuition and fees.

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 en-

gineering or computer science will be charged a tuition differential of $87.50 per semester. Students in these programs who are registered for Doctoral Research (999) or Master's Continuing Enrollment are considered full time and pay the full tuition differential. Students in these programs (both resident and nonresident) who register for fewer than 9 credits pay a differential tuition of $5 per credit hour.

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

Other Charges and Fees

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 zero credit are billed as if they were for one 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.

Student Accident and Sickness Insurance The University strongly urges all students to be insured against illness or injury that may arise in the course of the academic year. 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 Health Services. The cut-off date for enrollment is the second Friday following graduate registration. Insurance coverage is also available for the spouse or children of a student provided the student is also enrolled in the plan. For information on student and/or dependent insurance, call University Health Services (603-862-1530).

Refunds

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

Financial 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 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 reduction waivers awarded to graduate students on assistantships are considered to be nontaxable scholarships.

Scholarships and Fellowships

Graduate Scholarships for Merit A recipient of a graduate assistantship or a project assistantship who is newly admitted to a Ph.D. program and has outstanding qualifications may be awarded a Graduate Scholarship for Merit. 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

Graduate Tuition and Fees 1991–92, per Semester

	Full-time (9–16 credits)	Part-time (5–8 credits)	Part-time (1–4 credits)
N.H. Resident Tuition	$1645.00	$183.00 /cr. hr.	$183.00 /cr. hr.
Nonresident Tuition	4920.00	547.00 /cr. hr.	547.00 /cr. hr.
Doctoral Research	300.00	—	—
Master's Continuing Enrollment	150.00	—	—
Differential Tuition	87.50	5.00 /cr. hr.	5.00 /cr. hr.
Mandatory Fees*:			
Memorial Union	$ 54.50	$ 27.25	—
Student Services	13.00	6.50	—
Health Fee	106.00	53.00	—
Recreation Fee	25.00	12.50	—
Registration Fee:	—	$ 15.00	$ 15.00
Late Registration Fee:	$ 25.00	$ 25.00	$ 25.00

*Students registered for Doctoral Research (999) and students registered for Master's Continuing Enrollment are considered full time and are required to pay full mandatory fees.

The University reserves the right to revise its schedule of tuition and fees without notice.

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 400 assistantships are awarded annually. Appointments are normally for one academic year. An appointment may be renewed provided that funds are available and that the student's academic performance, as well as performance in carrying out the responsibilities of the assistantship, is satisfactory. Students normally are involved in assistantship activities for twenty hours a week. All graduate students holding appointments as assistants must be admitted on a regular or provisional basis to the Graduate School and must register for a minimum of 6 credits (maximum of 12 credits), or Master's Continuing Enrollment, or Doctoral Research during each semester in which they hold their appointments. Such students are considered full-time students. A limited number of newly admitted doctoral students who are awarded assistantships may also receive a Graduate Scholarship for Merit as explained above.

The 1991–92 academic-year base stipend levels for assistantships are $8,200 ($8,600 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 $8,500 ($8,900 in biochemistry, chemistry, computer science, engineering, mathematics, and physics).

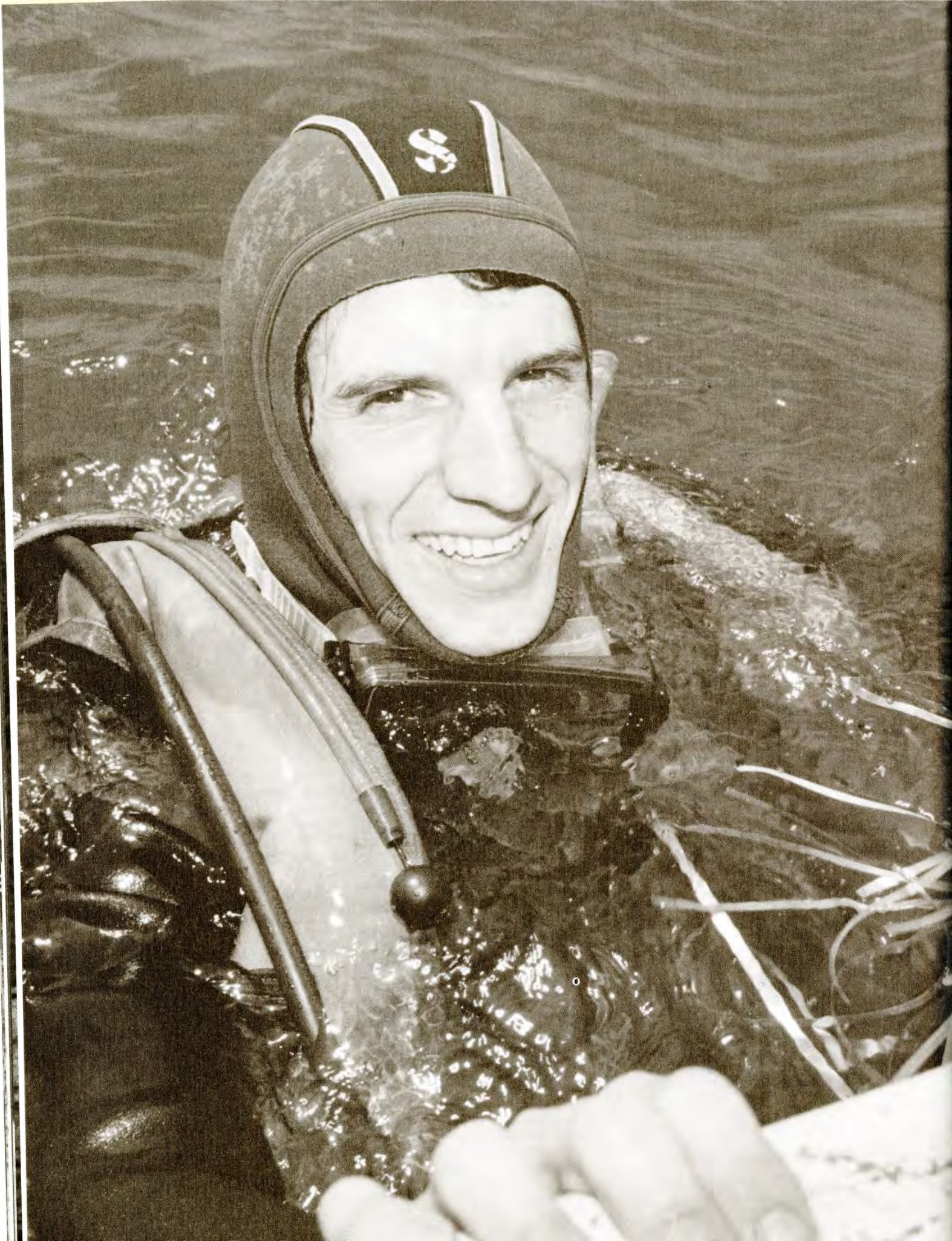
Inquiries regarding assistantships should be addressed to the chairperson or graduate coordinator of the appropriate department or program. Appointments are made in the following categories.

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 their appointment.



"There's a wasting disease that affects eel grass in the bays along the U.S. It thins out the grass beds and reduces their density. Since fish use these beds as habitats, we're looking to see what effect this reduced density is having on the fish. We're laying out beds of artificial grass—it looks like green ribbon, 5 millimeters wide, attached to PVC frames with monofilaments—to see if it will work as well as the natural eel grass. Will it have different numbers, species, or kinds of fish populations? We're still checking. For now, it lets us study the fish without disturbing the natural eel grass beds or the populations of fish that live there."

Mike Ganger
M.S. student
Department of Zoology
Center for Marine Biology

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

Other Forms of Aid

Limited amounts of aid from federal and state sources are available through the Financial Assistance Center. 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 national Financial Aid Form (FAF) should be submitted to the College Scholarship Service in Princeton, New Jersey, as soon after January 1 as possible but prior to February 15 for priority consideration for fall semester. The FAF 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 Financial Assistance Center in Stoke Hall. Telephone: (603) 862-3600.

Perkins Loans Graduate students may borrow up to $18,000, including any undergraduate loans. These loans have a simple interest rate of 5 percent annually. Minimum payments of $30 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 five 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.

College Work-Study Program With the aid of federal funds, the University is able to provide employment opportunities on campus or in various off-campus agencies. To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University and demonstrate financial need as determined by the Financial Assistance Center. Work during the academic year is usually on campus. Students interested in summer work-study should apply (and send their FAF to Princeton and submit separate application for the Summer College Work-Study Program to the Financial Assistance Center in Stoke 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. Interest is 3 percent on any unpaid balance and repayment begins 9 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.

Stafford (GSL) Student Loan Programs A Stafford (GSL) Loan is a low-interest loan made to a student-borrower by a bank, credit union, or savings and loan association. The interest rate varies between 7 and 9 percent. Graduate students may borrow up to $7,500 per academic year. The total maximum debt for graduate study is $54,750 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 6–9 months after students cease at least half-time attendance.

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 $4,000 per year to an aggregate total of $20,000. 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 12 percent. Additional information may be obtained at local lending institutions.

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 Veteran's 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 Assistance Center.

"When I first came to the Canterbury Shakers, I was eighteen months old. I have lived with them part and full time over the last 31 years. Shaker history has always been my first love and history has been my burning passion. I have taught history on the secondary level, even worked for a Japanese firm that imported tools. But I decided I wanted to teach in college, and I wanted to teach Shaker history. UNH has been very supportive in helping me realize this goal.

"I've focused my research at UNH on studying the connection between Mary Baker Eddy (who lived in nearby Bow and Sanbornton) and the Shakers. It's not necessarily true that she drew her religious ideas from the Shakers—but that is a possibility. They do share strikingly common features: both see God as father/mother, or two beings in one, each with totally different features. Now, how they arrived at their similar conclusions could be a matter of coincidence, or she may have come up with similar ideas on her own and merely had them confirmed by the Shakers—I'm not sure we'll ever know. There's a good chance her family and the village were connected with one another. And that connection may have contributed to her later philosophies. But this is just one facet of Shaker history—and certainly not the only important one. It's important to me to make sure the Shakers are remembered and their history carefully preserved. Their heritage, their incredibly rich legacy, will live on forever."

Darryl Thompson
M.A. student
Department of History

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

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

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

C, C+ Grades The dean of the Graduate School may, under limited conditions, approve up to 8 credits of C or C+ grades for graduate credit. When a student's advisory committee or a student's adviser, in conjunction with the appropriate departmental committee, wishes to recommend that credit be given for work completed with a C or C+, the advisory committee shall forward its recommendation, with appropriate justification, to the dean of the Graduate School within one month after conclusion of the course. Normally these courses will be elective courses outside the student's major area.

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

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

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

Incomplete Grades An "IC" grade is assigned with the approval of the instructor for excused unfinished work only. The work must be completed and submitted to the instructor by the last day of classes of the semester immediately following the one in which the incomplete was granted (800- and 900-level courses only; midsemester for 400-, 500-, 600-, and 700-level courses). A petition requesting an extension of time, approved by the instructor, may be submitted to the dean of the Graduate School by the appropriate deadline. An extension will be granted by the dean only under unusual circumstances. An incomplete grade automatically becomes an F if not removed or if a petition for an extension is not approved within the allowed time period. This policy also applies to students who withdraw from the University or who are not currently registered.

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

W Grades If a student withdraws from school or drops a course prior to the fifth Friday of classes, the course(s) will not appear on the student's permanent record. If a student withdraws from school or, for compelling nonacademic reasons, submits an approved petition to drop a course after the fifth Friday of classes, a notation of "W" will be shown on the student's academic record. If the withdrawal or drop is after midsemester, a WP/WF is shown on the record. A WF is considered a failing grade.

Academic Standards

Grades below the B- level, including grades of C or C+ that may have been approved for graduate credit, will, for the purposes of determining academic standing, be considered failing grades. Failing grades (below B-) received in undergraduate courses taken while the student is 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 13) may, upon recommendation of the department and approval of the Graduate School, be allowed a maximum of two graduate-level courses for up to eight 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 eight semester credit hours of resident courses completed on the campus of an accredited institution authorized to grant graduate degrees be transferred to count toward their graduate program. All courses presented for transfer must have been completed with a grade of B or better and must have been taken for graduate credit. Courses cannot be transferred for credit if used in earning another degree. Transfer of credits must be recommended by the program faculty and approved by the dean of the Graduate School. Students taking courses at another university for transfer after enrolling at UNH should obtain approval of their adviser and the graduate dean prior to enrolling in the course. Since the doctoral degree does not require a specific number of courses, credits are not normally transferred onto doctoral students' academic records.

Special Student Credits

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

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

Master's Degree Requirements

Credits A minimum of 30 graduate credits is required for all master's degrees. Many programs require substantially more than the minimum 30 credits. Individual program requirements are outlined in the program descriptions of this catalog. Graduate credits are normally earned in courses numbered 800–999. Up to 12 credits earned in courses numbered 700–799 may be taken for graduate credit by master's degree students provided the courses are approved by the dean of the Graduate School and given in a department other than the one in which the degree is earned. A maximum of 12 credits taken by a student prior to admission can be applied to a degree program.

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

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

Time Limit All graduate work for any master's degree must be completed within six years from the date of matriculation (admission/enrollment) in the program. Progress toward the degree will be carefully monitored by the adviser and the Graduate School to ensure that adequate advancement is made toward the completion of the program and that any deficiencies noted at the time of admission are removed.

Nonthesis Option

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

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

Thesis Option

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

Thesis Credit A minimum of 6 and a maximum of 10 thesis credits may be applied toward a master's degree. The exact number of credits 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 as soon after approval as possible, but not less than two weeks before Commencement. See Graduate School Calendar for deadlines. 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 Re-

search 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 As soon after the examination as possible, but not less than two weeks prior to Commencement, three copies of the approved dissertation, ready for binding, shall be turned in to the Graduate School Office. See Graduate School Calendar for deadlines. 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*.

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

The University has many diversified research projects, ranging from highly specialized investigations in the physical and biological sciences to broad interdisciplinary marine studies. Graduate students are involved in research as project assistants working on research leading to master's theses and doctoral dissertations. Research and educational activities are conducted not only in individual departments but also in multidisciplinary research centers and institutes.

Agricultural Experiment Station

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

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

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

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

The number of research problems requiring contributions from many different fields, as well as an understanding of the complex connections among different components, has grown substantially in recent years. For example, the changes in climate that can be expected from the worldwide consumption of fossil fuels, the influence of solar luminosity changes on the climate, the ongoing alterations in the Earth's albedo resulting from changing land use, the ability of the oceans to assimilate wastes, the sensitivity of stratospheric ozone to trace gases such as fluorocarbons, and the translation of scientific studies of these problems into public policy—these are all examples of fundamental issues that require a global, multidisciplinary approach.

Faculty members working in the Institute for the Study of Earth, Oceans, and Space are affiliated with academic departments through which graduate degree programs are offered. The degree programs currently offered are the physics degree with specialization in space science, the earth sciences degree with an option in oceanography or specialization in geochemical systems, and the 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 54 for a description of these courses, and pages 55, 90, and 97 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

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 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).

Marine Systems Engineering Laboratory

The MSEL is involved with the research and development of intelligent underwater systems. The primary research emphasis of the laboratory is the development of technologies related to autonomous underwater vehicles and robotics. The mission of MSEL is to build and maintain a base of technical excellence in ocean sys-

"I work on the Burst and Transient Source Experiment part of the Gamma Ray Observatory project. It's a unique project, in that the device scans the entire sky at once. Think of the sun's interesting corona that can only be seen during solar eclipses. This corona, for some reason, is hotter than the surface of the sun. If you think of a fire, you know that the hottest part of the fire is in the center of the flame. How then is the corona hotter than the surface of the sun? Something must be trapping the heat above the sun and amplifying it to cause this effect. One hypothesis is that the flares contribute to this effect. Large solar flares occur every few days. Small ones occur more frequently. I'm hoping in my work to see if minute solar flares, ones that are still too small to measure now, occur all the time. Then maybe we can collect enough data to figure out whether or not these flares cause the sun's corona to be so hot."

Doug Biesecker
Ph.D. student
Department of Physics
Member of the Gamma Ray Observatory Team

tems related to educational, research, and service activities within UNH. A major goal of the laboratory is to make use of the skills and enthusiasm of students by employing their talents in project roles to provide practical experience in engineering. The research at the laboratory centers around two experimental autonomous undersea submersibles (EAVE vehicles) which act as development testbeds for intelligent undersea systems research.

Ocean Process Analysis Laboratory

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 both 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 University Diving Program, the University research vessel, *Jere A. Chase*, 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 in 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.

Ocean Engineering Center

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 Marine System Engineering

"I have been working in the Amazonian rain forest for five and a half years. First, at the National Institute for Amazonian Research in Manaus, Brazil—the largest such institute in the Amazon. My first work was with soils evaluating how soils evolve there and how they relate to the rain forest. There are huge dam projects in Brazil, and I worked on an environmental impact study to estimate the kind of impact these projects would have. I quickly began to realize that the rain forest is beyond the confines of any one study. Even though the rain forest is well known to popular audiences because of the media attention, scientifically very little is known about the forest. There are less than 1,000 Brazilian scientists working in an area roughly the size of the continental United States. And the diversity is staggering. In all of New England you might find 20 to 30 species of trees. In the rain forest, you'd find 200 to 300 in an acre. And the same acre would probably have 10,000 different species of insects. How do you begin to do an impact study on such a place—when you don't even know what's there?

"Working in this area, I decided we needed better scientists and I needed more training. The first ten minutes I was at UNH I decided to come here. It's not a big university and it allows graduate students to find their own way. I am so much committed to what I am doing. I'm not just getting a degree, I'm becoming better at my job, and that will affect what's going on in the rain forest."

Antonio Nobre
Ph.D. student
Department of Earth Sciences

Laboratory (MSEL), 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 MSEL and 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 Ocean Engineering Center 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 is necessary to understand oceanic processes.

Sea Grant College Program

The Sea Grant College Program at the University of New Hampshire—a joint program with the University of Maine—works cooperatively with marine industries, state and federal agencies, organizations, and individuals to identify and solve problems associated with the development and conservation of northern New England's marine resources. The program also increases public awareness of important marine and coastal issues through its education and advisory efforts.

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.

Center for Business and Economics Research

The Center for Business and Economics Research provides applied research and information facilities for business and economic indicators. It develops multi-sectional, 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 dissemination of educational and research materials; it fosters and develops relevant outreach activities in the humanities for the state and region; and it is a focus for the humanities within the University, the state, and the region.

Center for Venture Research

This multidisciplinary community of scholars and professionals is dedicated to the study and promotion of innovation, entrepreneurship, and economic development. The center pursues its objectives in three distinct ways: *research*, *service*, and *educa-*

tion. 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 physiochemical 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.

Human Nutrition Center

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

Institute for Policy and Social Science Research

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

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, 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 will contribute to the solution of national water resource problems. Both undergraduate and graduate students are involved in the research projects conducted in individual departments and other facilities provided by the University.

Writing Process Laboratory

This laboratory provides unique opportunities for graduate students 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 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 970,000 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 now computerized. Our 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. Our OPAC displays not only the holdings of the University library and Durham Public Library but also those of several area libraries.

Government Documents receives 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. It lends access and borrowing capabilities from libraries world wide. The library is a member of CRL (Center for Research Libraries) which provides unlimited access to international doctoral dissertations and periodicals, older monograph materials, large microfilm collections, and over 4,000 newspaper titles. The reference department can help graduate students locate and request material from CRL.

The library also 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 children through teenaged children.

Computer Resources

The computing environment at UNH is a richly diversified network of microcomputers and mainframes. Every UNH student has computer access, both to mainframe computers and to microcomputers.

UNH has five conveniently located microcomputer centers for use by students through the DISCovery (Directions in Instructional and Scholarly Computing) Program. These centers are equipped with more than 150 AT&T 6300 (IBM-compatible), IBM PS/2, and Apple Macintosh personal computers and compatible printers. Each center also has a library of software for word processing, spreadsheet, graphics, modeling, and statistical analysis. The centers are staffed by student consultants who help users with questions or problems. Documentation is also available. Some students use their own software or class-specific software provided by their instructors.

The University has three large computers available for academic use by students and faculty members: a VAX 8820 multiprocessor, a VAX 8650, and a VAX 5819, running the VMS, ULTRIX, and RISC-ULTRIX operating systems. These computers operate 363 days a year, 24 hours a day. There are approximately 300 remote terminals and graphics devices in classrooms, the library, and other convenient places on campus.

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

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

The Research Computing Center houses four large Prime systems: a 6650, 6550, 9955-II, and a 4150, running the PRIMOS operating system and UNIX systems made by various vendors. There are also a MicroVAX II and a Prime 2655 for research testing. All systems are interconnected using Ethernet and PRIMENET local area networks. Some students involved in research projects use workstations in the CADAG (Computer-Aided Design and Advanced Graphics) laboratory to access Prime's MEDUSA software, a program that generates high-quality mechanical drawings, on the Prime 9955-II computer.

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

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

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. Additional support and training are available through course handouts, documentation and guides, VAX online HELP, and on-disk tutorials.

Organizations

Graduate students are an integral part of the University community. Yet they have needs and interests that differ from other


FINISH

"I work with preschool children—they're a lot of fun. It's an important age to catch speech problems. The earlier you start working with a child, the better chance you'll have to correct the speech/language disorder before it has a psychological or social impact on the child's development. If they don't have good language skills, how will they learn to read? They will also have difficulty forming relationships—and children must have social interaction. It can lead to low self-esteem. They might see themselves as a 'dummy'—since other children call them that—and eventually it becomes a self-fulfilling prophesy. The expectations aren't there."

Debbie Bryer
M.S. student
Department of Communication Disorders

University groups. Thus, the Graduate School, the University, and the Graduate School 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 T.V. and study lounge with tables and comfortable seating is located on each floor. On the ground floor, students can relax in front of the fireplace in the main lounge, unwind with a game of ping-pong in the recreation room, or check out sports equipment for use outside. Other facilities in the hall include a photography darkroom, piano, locked bicycle storeroom, coin-operated laundry, vending machines, luggage storage areas, and individual mailboxes. All student rooms are single occupancy. Each room is furnished with a bed, easy chair, desk and chair, wardrobe, clothing drawers, medicine cabinet, mirror, and lights.

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

Following acceptance to the Graduate School, each student will be contacted about housing by the University's Department of Housing, Pettee House, University of New Hampshire, Durham, NH 03824.

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

To be eligible for housing, all graduate students must be admitted to the University and be considered full time as defined in this catalog. Students may apply for Forest Park before fulfilling the above requirements, as long as the requirements are met at the time of assignment. All interested individuals must fill out an application form available at the Forest Park Office. Generally, most applicants are offered an apartment within six months of application. A brochure and application can be requested by writing to Forest Park Resident Manager, 160 Forest Park, University of New Hampshire, Durham, 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, Durham, NH 03824) 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 (phone 603-862-2136) or to access the housing list on VideoTex.

Dining Facilities

Graduate students may elect to take their meals on a contractual basis with the University dining halls whether they live on campus or not. There are limited cooking facilities in Babcock House and none in individual rooms. Students may purchase a 13- or 19-meal plan, a 5-lunch semester plan, an "any 35 meals" plan or Cat's Cache (a pre-paid food charge account). Students often open a Cat's Cache account in conjunction with another meal plan and use it to purchase meals and snacks at the MUB Cafeteria and Wildcatessen. Dining plans may be purchased through the Dining Business Office either before undergraduate registration or after classes begin, or on the lower level of Huddleston during undergraduate registration. A check, money order, or cash payment is required. Admission to meals is by photo ID. Information about meal plans is available from UNH Dining, Stillings Hall.

Meal Service and Menu Information Dining hall hours and services are listed in VideoTex and posted in the residence and dining halls and at the MUB Information Center and the Commuter/Transfer Center. Menus are published in *Scoop*, a weekly newsletter distributed to students in the dining halls.

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

Memorial Union

The Memorial Union, the only New Hampshire state war memorial, is the University's community center. It serves as the focus for many student programs and provides services for the entire University community. Students, faculty, and staff on the Memorial Union governing board work with the director to set policies for the building's operation and those student activities related to the building. Building services include the University Information Center and Ticket Office; the Cat's Closet, a convenience store; Wild Cards, offering greeting cards, balloons, and photo processing; a computer center housing Project DISCovery; and a food service operation consisting of a cafeteria, Pistachio's Sweet Shoppe, and catering service. The games area has video machines, candlepin bowling lanes, and billiard tables. The Commuter/Transfer Center, ACCESS office, and various student organizations are also located in the Memorial Union.

University Health Services

The University Health Services provide comprehensive primary health care, including laboratory examinations, x-rays, limited physical therapy, pharmacy services, and limited mental health care. Both inpatient and outpatient care are available. 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 AIDS, alcohol, smoking, women's health, birth control, heart disease, sexuality, eating disorders, 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; consultant 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, Leary Lab, etc.); contraceptive devices or medicines; orthopedic appliances or casts; 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 12 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 center sponsors a variety of student-oriented activities including personal skills groups on such topics as communication, values clarification, and life planning. 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 Planning and Placement Service

The Career Planning and Placement Service assists students in planning for professional careers and helps with eventual job placement. The assistance available to students includes an on-campus recruiting program between November and May, a library of information on employers and career opportunities, placement techniques workshops, and aid in finding summer jobs and full-time employment. The service will also forward students' credential files to prospective employers/graduate schools and provide assistance to alumni.

VideoTex carries a complete listing of career placement and planning offerings, including when recruiters are coming.

Multicultural Student Affairs

The Office of Multicultural Student Affairs assists in student development by ensuring that all students—regardless of race, gender, religion, national origin, or sexual orientation—have the opportunity to be included in every facet of the campus community and have access to all academic, social, and recreational groups and activities. 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 campuswide multicultural programs.

NHCUC Job Referral Service

The New Hampshire College and University Council, of which UNH is a member, funds a Job Referral Service (JRS) for students and alumni. In addition to coordinating two annual job fairs, they produce a publication, *JOBLINE*, a listing of specific jobs listed with member schools. The service may be contacted through the University's Career Planning and Placement Service.

International Student Office

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

Other Services

ACCESS Office Students with a physical or mental disability that limits one or more major life activities, such as walking, seeing, hearing, speaking, working, or learning, are encouraged to inform the ACCESS Office (Accessing Career Challenges in Education through Specialized Services), Room 200, Memorial Union Building, 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 other commuter-related problems. Lists of available rental houses, apartments, rooms, and names of people looking for roommates are published weekly and on VideoTex.

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 (603) 862-2835 for further information.

SHARPP The Sexual Harassment and Rape Prevention Program (SHARPP) is dedicated to providing a safe environment for all members of the University community. The program offers campus-wide rape awareness workshops and a support group for survivors through Counseling and Testing. Sexual assault advocates are trained volunteer women and men who offer confidential assistance to students who have been sexually violated.

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.

VideoTex The VideoTex computer system, with terminals located conveniently around campus (in the MUB, library, Field House, Elliott Alumni Center, Thompson Hall, and elsewhere), gives users quick and easy access to information about the University—daily events, clubs, activities, University policies, important phone numbers, etc. VideoTex is updated daily through the Information Resource and Assessment Office. Call 862-4253 for information.

Departmental Requirements and Course Descriptions

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

Course Description Key

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

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

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

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

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

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

Animal and Nutritional Sciences (ANSC)

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

Degrees Offered

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

Admission Requirements

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

M.S. Degree Requirements

A student will meet the Graduate School's requirements for the master's degree and must defend a thesis based on a research problem. The program may include no more than 6 credits of thesis research and no more than 4 credits of investigations. Each candidate must present at least two seminars (exclusive of the thesis defense) and must serve as a teaching assistant for one semester.

Ph.D. Degree Requirements

A minimum of 20 graduate credits (exclusive of dissertation research) beyond those required for an M.S. degree, or a minimum of 48 course credits without an M.S. degree, is required. However, it is expected that most students will accumulate additional course credits beyond these minimal requirements. A guidance committee will assist the candidate in designing the program of study. Upon completion of graduate courses and demonstration of computer literacy, a doctoral student will be required to pass an oral qualifying examination conducted by the guidance committee. This examination may include a written component at the discretion of the committee. After the student's advancement to candidacy for the Ph.D. degree, a doctoral committee will be appointed to supervise and approve the dissertation and to administer the final examination, which will be primarily an oral defense of the dissertation. During the tenure of the Ph.D. program, the candidate will be required to serve as a teaching assistant for two semesters or to teach a course for one semester.

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

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

806. Physical Performance Enhancement
The integrated application of principles of sports nutrition, exercise physiology, and biomechanics to improve physical performance in various mammalian species. Prereq: one semester of nutrition and one semester of exercise physiology or permission. 4 cr.

814. Research Methods in Endocrinology
Application of modern laboratory techniques to the study of hormonal and molecular mechanisms in the endocrine system. Prereq: ANSC 701 or BCHM 751 or ZOOL 704; permission. Special fee. Lab. 4 cr.

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

817. Mammalian Physiology I
Systems-level course with emphasis on basic physiologic concepts and the functional principles of the nervous, muscular, skeletal, and cardiovascular systems. Prereq: one year of intro. animal anatomy and physiology and one semester of biochem. or permission. 4 cr.

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

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

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

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

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

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

855. Disorders in Energy Balance
Etiology, pathophysiology, and treatments of obesity, anorexia nervosa, and 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.)

903. Energy Metabolism and Nutrition
Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. 3 cr. (Not offered every year.)

904. Protein Metabolism and Nutrition
Metabolism of dietary amino acids in the mammalian system with emphasis on various aspects of protein nutrition. Prereq: permission. 4 cr. (Not offered every year.)

905. Intermediary Metabolism and Exercise
Regulation of mammalian cellular metabolism by enzymes, effectors, hormones, and diet in muscle, liver, and adipose tissue, and response of these tissues to exercise. Prereq: BCHM 658, ZOOL 507-508. 4 cr. (Fall semester only.)

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

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

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

953. Advanced Cell Biology
Study of the ultrastructure and function of cell organelles followed by an analysis of various specialized animal cells to show how differences in form and location of various organelles lead to differences in function. Prereq: biochemistry; physiology; vertebrate anatomy;/or permission. 4 cr. (Not offered every year.)

995, 996. Research in Animal Sciences
Advanced investigations in a research project, exclusive of thesis project. Elective only after consultation with the instructor. May be repeated. 1–4 cr.

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

899. Master's Thesis
6 cr.

999. Doctoral Research

Biochemistry (BCHM)

Chairperson: Donald M. Green
Professors: Donald M. Green; Samuel C. Smith; James A. Stewart
Associate Professors: Clyde L. Denis; Anita S. Klein; Thomas M. Laue; Stacia A. Sower
Assistant Professors: John J. Collins; Rick H. Cote; Andrew P. Laudano
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 students in the master's program. All candidates for the M.S. degree will be required to pass an oral examination based on the thesis or project report and on the graduate courses completed in the degree program.

Ph.D. Degree Requirements

Doctoral students will be required to complete a dissertation on original research in biochemistry. At the end of the first year of graduate study, a preliminary examination on organic chemistry, physical chemistry, and general biochemistry will be presented to students in the doctoral 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.

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

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

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

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

860. Cellular Signalling Processes
Metabolic basis of cellular communication and signal transduction. Activation of membrane receptors by external stimuli; signal transducer proteins; classes of intracellular messengers; biochemical basis of regulation of enzymes resulting in cellular metabolism. Prereq: BCHM 851. 3 cr.

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

865. Molecular Biology and Biochemistry of Plants
Molecular mechanisms and regulation of the metabolic functions of plants. Structure and function of cellular constituents; roles of secondary metabolites in plant-microbe interactions. Prereq: BCHM 658 or 752; BIOL 604 strongly recommended. 3 cr.

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

872. Introductory Laboratory in Molecular Genetic Techniques
Modern biochemical gene manipulation techniques including the genetic, physical, and enzymatic characterization of gene vectors, gene cloning, construction of genetic probes, and sequencing of nucleic acids. Prereq: BCHM 852; BCHM 871 or MICR 804. (Also offered as GEN 872.) Special fee. 3 cr.

895. Investigations in Biochemistry
Prereq: permission. Subject matter and hours to be arranged. 1–4 cr.

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

942. Biochemical Regulatory Mechanisms
Nonreplicative functions of DNA; transcription and translational control of protein synthesis; quantitative regulation of proteins; regulation of metabolism by hormones, allosteric regulation and repression; regulatory mechanisms operating during development and differentiation. Prereq: BCHM 852 or permission. (Also offered as GEN 942.) 3 cr.

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

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

997, 998. Biochemistry Seminar
Prereq: permission. 1 cr. Cr/F.

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Biology

Chairperson: James E. Pollard
Graduate Admissions Coordinator: Wayne R. Fagerberg

Degree Offered

The master of science degree in biology is a nonthesis program in general biology. It is designed primarily for secondary school science teachers and others who wish to enhance their academic credentials in biology, and who do not require experimental research experience. The program is not intended as a prerequisite to doctoral programs and, therefore, may not satisfy admissions requirements for some of these programs. Students admitted to the program will be referred by the graduate admissions coordinator to an appropriate adviser for program planning. The adviser may serve as chairperson of the student's M.S. program guidance committee. Faculty members who currently serve as advisers are from the following discipline areas within biology: molecular, cellular, and developmental biology; ecology; evolutionary biology; physiology; anatomy; nutrition; genetics; and pathobiology. Specific program requirements and guidelines are available from the graduate admissions coordinator.

Admission Requirements

Applicants must have a bachelor's degree with a major in one of the biological sciences or a strong background in the biological and physical sciences. In addition to requirements listed under the application procedures section in the *Graduate Catalog*, applicants must also submit general and subject biology scores from the Graduate Record Examination.

Degree Requirements

Students must meet the Graduate School's requirements for the master's degree, complete a final comprehensive examination on program coursework, and present a seminar on a four-credit research paper. The research paper and coursework will focus on a biological topic of specific interest to the student which has been approved by the guidance committee. To ensure a reasonable breadth in preparation, the student is expected to select courses from several biological sciences departments. Persons interested in this degree should contact the graduate admissions coordinator for further information.

Business Administration (ADMN)

Professors: Stephen L. Fink; John Freear; Lyndon E. Goodridge; Charles W. Gross; Jonathan Gutman; James O. Horrigan; Fred R. Kaen; Marvin J. Karson; Barry Shore; Linda G. Sprague; William E. Wetzel, Jr.; Dwayne E. Wrightsman
Associate Professors: John H. Barnett; Gene Boccialetti; Ahmad Etebari; Francine S. Hall; Jinoos A. Hosseini; Allen M. Kaufman; Michael J. Merenda; Starr F. Schlobohm; Jeffrey E. Sohl; Rita Weathersby
Assistant Professors: William Naumes; R. Dan Reid; 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.

Admission Requirements

The Whittemore School welcomes applicants with an above-average academic record in any undergraduate specialty. The crucial requirement for admission into the M.B.A. program is a history that demonstrates that the applicant has the potential and desire for graduate study in business. The focus of the student's earlier education is of less importance than evidence of academic ability and potential for becoming a responsible manager and leader. Consequently a "portfolio" approach to admissions is adopted, in which an applicant's work and military experience along with other indications of maturity, motivation, and self-discipline are considered as well as the applicant's test scores and academic record. All applicants are required to take the Graduate Management Admission Test (GMAT). Applicants are expected to have successfully completed one year of college mathematics or have demonstrated proficiency in quantitative reasoning. Interested applicants are encouraged to contact George T. Abraham, Director of Graduate and Executive Programs, Whittemore School, UNH, Durham, NH 03824.

Day M.B.A. Degree Requirements

The Whittemore School curriculum for day students consists of an integrated sequence of eighteen to twenty courses normally requiring two years of full-time study. During the first year, ten required courses in the basic disciplines 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. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University, as well as by the Whittemore School, and to undertake field studies or internships.

At the time of this printing, the faculty is considering changes in the curriculum. Please check with the program director for an up-to-date listing.

Curriculum

First Year
Semester I
Financial Accounting
Applied Microeconomics
Managerial Statistics
The Organization and Its Environment
Marketing

Semester II
Managerial Accounting
Financial Management
Operations Management
Empirical and Modeling Methods in Business
Organizational Behavior

Second Year
Semester I
Applied Microeconomics
4 or 5 open electives

Semester II
Strategic Management: Decision Making
4 or 5 open electives

Executive M.B.A. Requirements

The curriculum for practicing managers contains the same 12 core course requirements as the day M.B.A. as well as a required Integrative Management Seminar that runs throughout the program and 5 elective courses. One of the electives must include either a research project during the summer between the two years or an international residence prior to the last term of enrollment. 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 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.)
3 required courses
Integrative Management Seminar
Term 2 (Jan.–Apr.)
3 required courses
Integrative Management Seminar
Term 3 (Apr.–June)
2 required courses
Integrative Management Seminar
Summer
Research Project (optional)

Second Year
Term 1 (Sept.–Dec.)
2 required courses
1 elective
Integrative Management Seminar
Term 2 (Jan.–Apr.)
1 required course
2 electives
Integrative Management Seminar
International Residence (optional)
Term 3 (Apr.–June)
1 required course
1 elective
Integrative Management Seminar

International Residence During the second year of study, via case studies, guest presenters, and optional 10-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.

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 manag. accounting;/or permission. 3 cr.

822. Cost and Management
Effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Analysis of cost behavior, direct and absorption costing, cost-price-volume relationship, distribution costs, transfer pricing, and capital budgeting analysis. 3 cr.

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

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

826. Decision-Support Systems
Exploration of computer usage in support of the problem-solving and decision-making process. Topics include conceptual foundations of decision-support systems, design of decision-support systems, spreadsheets, data base, and expert systems. Use of main frame and microcomputers, cases, projects; guest speakers. 3 cr.

827. Topics in Accounting
Special topics. 3 cr.

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

832. Exploration in Entrepreneurial Management
Examination of the management of change and innovation with particular attention to the role of the entrepreneur in the management of new ventures. Characteristic behavioral, organizational, financial, and marketing problems of entrepreneurs and new enterprises. 3 cr.

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.

837-839. Advanced Financial Accounting I-II
Theory and practice of income measurement and asset valuation; consolidations, partnerships, leases, pensions, price-level reporting, foreign currencies, and fund accounting. 3 cr.

840. International Business
Issues and problems confronting managers in the international economy. Emphasis on problems of working across national borders rather than on those encountered within the framework of different national economies, cultures, and institutions. For managers working in a multinational enterprise. 3 cr.

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

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

844. Strategic Management of Operations
Review and application of operations management techniques and methodologies to the development of operations strategies. Projects with client firms including operations analyses leading to recommendations for the development of the firm's strategic operations posture. Prereq: permission. 3 cr.

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

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

848. Law: Use and Application in Business
Use and understanding of law as it applies to business judgement and policy decision making; basic legal rules and their application. Contracts, corporations, agencies, partnerships, administrative agencies, commissions, and other related business matters. Case-method teaching with outside research. 3 cr.

849. Management Information Systems
Concepts, design, and implementation of systems to provide information and support for managerial decision making. Use of computers, models, and behavioral factors from the manager's perspective. 3 cr.

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

851. Advertising and Promotion
Advertising, personal selling, and other promotional tools to help solve marketing problems; advertising as a medium of communication and as a social-cultural force in the Western world. 3 cr.

852. Marketing Research
Identification, collection, and analysis of data for the marketing process. Strengths, limitations, environment, and evaluation of research in the marketing process. 3 cr.

855. 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.

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

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

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

870. Personnel Administration
Role of personnel administration and human resource management in achieving goals in "for-profit" and "not-for-profit" organizations. Functions of management; scope, technique, and current issues of personnel administration; organization of personnel activities and staff. How managers relate to personnel administration and interact with personnel administration staff and services. 3 cr.

875. Labor-Management Relations
Study of the legal, economic, and institutional environment within which labor-management relations occur and a study of the processes and goals that determine the rules governing labor-management relations. Focus on relations in the U.S., covering union and non-union and private and public enterprises. Issues considered include employee discipline, seniority and performance appraisal, and job rights versus management rights. Grievance administration, arbitration, and contract negotiations are examined. 3 cr.

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

885. Career Management
Develops individual career management skills. Topics include concepts of career development and issues pertaining to career management in organizations. Helpful for students interested in human resource management. 3 cr.

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

900. Integrative Management Seminar
This course extends throughout the Executive M.B.A. Program. Material and topics not offered in regular courses are offered here, as are distinguished speakers from business and government, field trips, issues of immediate concern, etc. 0, 2 cr. Cr/F. (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 organizations. 3 cr.

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

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

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

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

942. Survey of Management Science
Survey of mathematical aspects of decision making and the use of the computer in the decision-making environment. Development and analysis of basic principles and methods of management science as applied to decision making in the public and private sector. Emphasis is on the methods and techniques that form the basis of management science, mathematical model formulation, real world applications, and computer solution of the model. 3 cr.

943. Computer-Based Corporate Planning Techniques
Computer-based techniques and models for planning: model construction, validation, and evaluation; data collection and analysis; system characteristics; evaluation of alternatives. Student projects required. 3 cr.

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

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

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

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

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

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

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

992. Independent Study
Projects, research, and reading programs in areas required for concentration. Sixty days advance approval of the student's plan of study by adviser and by proposed instructor required. Maximum of 8 credits, except by special permission. Variable credit, 1–6 cr.

Chemical Engineering (CHE)

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

Degree Offered

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

Admission Requirements

An applicant is expected to have completed a baccalaureate degree in chemical engineering. Students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

M.S. Degree Requirements

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

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

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

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

809. Fundamentals of Air Pollution and Its Control
The origin and fate of air pollutants. Fundamentals of atmospheric meteorology, chemistry, and dispersion phenomena. Control of air pollutants and the related equipment. Current issues. Prereq: differential equations with linear algebra; general chemistry. Lab. 4 cr.

812. Introduction to Nuclear Engineering
Development of nuclear reactors; binding-energy; radioactivity; elements of nuclear reactor theory; engineering problems of heat transfer, fluid flow, materials selection, and shielding; environmental impacts. 4 cr. (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: a knowledge of FORTRAN programming. Lab. 4 cr. (Not offered every year.)

852. Process Dynamics and Control
Dynamic behavior of chemical engineering processes described by differential equations; feedback control concepts and techniques; stability and analysis. Lab. 4 cr.

854. Graphical, Numerical, and Finite Element Applications in Chemical Engineering
Computational methods for solving differential equations resulting from the modeling of a process or physical phenomenon. Graphical display of results of data and of curve-fitted equations. Use of interactive graphics and the solution of boundary-value problems. Applications of finite element analysis and discussion of other software available. Prereq: permission; knowledge of FORTRAN programming. 4 cr. (Not offered every year.)

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

872. Physicochemical Processes for Water and Air Quality Control
Origin and characterization of pollutants. Controls, including filtration, sedimentation, coagulation and flocculation, absorption and adsorption. Applied fluid mechanics, mass transfer, and kinetics. Thermal pollution, chemical treatment, oil spills on water, and aeration. Lab. 4 cr. (Not offered every year.)

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

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

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

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

916. Diffusive Mass Transfer
Physical aspects of diffusion; theories of diffusion in dilute gases, dense gases, liquids, and solids; surface diffusion; mixing processes. Simultaneous heat and mass transfer. 3 cr.

923. Advanced Chemical Engineering Thermodynamics
The multicomponent open system; the volumetric and phase behavior of pure substances and of multi-component systems at physical and chemical equilibrium, fugacity and activity; thermal properties of equilibrium, chemically reacting systems; introduction to statistical thermodynamics. 3 cr.

932. Advanced Chemical Engineering Kinetics
Specialized applied kinetics problems; catalysis; fast reaction and shock tubes; combustion and detonation processes; nonisothermal kinetics; heat and mass transfer in nonequilibrium, chemically reacting systems. 3 cr.

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

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

998. Graduate Seminar
Discussion on topics of interest to graduate students and staff; reports of research progress; invited lectures by outside speakers. 0 cr.

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

999. Doctoral Research

Chemistry (CHEM)

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

Degrees Offered

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

Admission Requirements

Admission to the master of science and the doctor of philosophy degrees is based upon a strong undergraduate record and requires satisfactory work in the usual undergraduate courses in inorganic chemistry, analytical chemistry, organic chemistry, and physical chemistry, as well as the normal supporting courses in mathematics and physics.

Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting each new student's graduate work at the proper level. These examinations will be offered at the beginning of each semester on dates announced in the departmental graduate calendar.

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

M.S. Degree Requirements

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

Master of Science for Teachers Degree Requirements

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

Ph.D. Degree Requirements

The doctoral degree requires completion of coursework appropriate to the student's field of study and the completion of a research problem presented in the form of a 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) present and defend 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 departments. In these programs, the graduate student, with the advice of the guidance committee, elects courses in chemistry and in the related disciplines, and writes the dissertation on a research problem appropriate to interdisciplinary treatment. Students interested in these programs should write to the graduate coordinator for further information.

Teaching Requirement

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

Analytical Chemistry

862. Instrumental Methods of Chemical Analysis
Theory, instrumentation, and application of methods such as atomic absorption, coulometry, emission spectography, 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 corequisite;/or permission. 3 cr.

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

931. Advanced Electrochemical Methods
Theory and application of important electrochemical techniques such as potentiometry, 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, optimization procedures. Examples drawn primarily from the analytical chemistry literature. 2 cr. (Not offered every year.)

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

934. Chemical Equilibria
Formulation and solution of chemical equilibrium problems of relevance to analytical chemistry, particularly multiphase separations. 2 cr. (Not offered every year.)

935. Analytical Instrumentation
Introductory electronics for chemists. Emphasis placed on how electronic components and circuits affect acquisition, manipulation, and quality of chemical information. Includes optical transducers and detectors and signal processing. 3 cr. (Not offered every year.)

Inorganic Chemistry

874. Inorganic Chemistry
Basic theoretical concepts and their applications 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 current trends in inorganic research. 3 cr.

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

Organic Chemistry

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 I
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 methodology and applications in multiple syntheses. 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 molecular structure. Lab. 4 cr.

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

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

921. Physical Chemistry—Chemical Kinetics
The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to very rapid reactions. Prereq: one year of physical chemistry. 3 cr.

922. Physical Chemistry—Chemical Thermodynamics
The foundations and interrelationships of the laws of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. 3 cr.

926. 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 applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. Scattering theory. Molecular reaction dynamics. May be offered as a tutorial. 3 cr. (Not offered every year.)

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

General Offerings

Courses in which all areas of specialization participate.

808. Research Techniques
Selected instrumental and chemical methods used in chemical research for the separation, identification, and structural analysis of chemical compounds. Typical topics include mass spectroscopy, NMR spectroscopy, IR and UV spectroscopy, and chromatographic methods. 1–4 cr.

907. Introduction to Research
A course to introduce the doctor of philosophy student to the planning, experimental methods, and interpretation of a research problem. Student presents and defends an original research proposal before a faculty committee. Must be completed satisfactorily by all doctoral students. Cannot be used for credit by master of science candidates. 2 cr.

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: David L. Gress
Professors: Otis J. Sproul; Tung-Ming Wang
Associate Professors: Thomas P. Ballestero; Jean Benoit; Michael R. Collins; Pedro A. de Alba; Charles H. Goodspeed; David L. Gress; Robert M. Henry; Nancy E. Kinner; Paul J. Ossenbruggen
Assistant Professor: James P. Malley, Jr.
Research Assistant Professor: T. Taylor Eighmy
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. The environmental and water resources areas offer a joint program in hazardous waste management. Interested applicants are encouraged to write the graduate program coordinator for specific information on current research in the department.

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

Admission Requirements

An applicant must have completed a baccalaureate degree in engineering, mathematics, or science at an accredited college or university. If coursework or laboratory experience is deficient, an admitted student will be required to fulfill, without graduate credit, all undergraduate prerequisites for graduate courses. In some cases the student's adviser may require additional undergraduate courses in 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. Optimization of Engineering Systems
Application of methods to the optimum design of structures, treatment plants, and other large-scale facilities. Topics include linear and nonlinear programming, numerical methods, and linear regression analysis. Prereq: permission. 3 cr.

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, water and wastewater 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 septage treatment. Prereq: intro. environ. pollution control. 3 cr.

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

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

845. Engineering Hydrology
Hydrologic cycle, probability theory related to hydrology and the design of water resources structures, flood discharge prediction, hydrograph development, hydraulic and hydrologic river routing, reservoir routing, theory of storage, reservoir operations, hydropower development, multipurpose projects. Prereq: permission. 3 cr.

847. Introduction to Marine Pollution and Control
Introduction to the sources, effects, and control of pollutants in the marine environment. Dynamic and kinetic modeling; ocean disposal of on-shore wastes, shipboard wastes, solid wastes, dredge spoils, and radioactive wastes; and oil spills. Prereq: water and wastewater engineering or permission. 3 cr.

848. Solid Waste 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: water or wastewater engineering or permission. 3 cr.

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

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

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

855. Design of Water Transmission Systems
Pressure, sewer, and open channel system design. Theory developed for individual components to large complex systems. Topics include closed conduit flow, open channel flow, pressure surge, design of storage, valves and meters, pump selection, system planning and layout, and system operation and maintenance. Prereq: fluid mechanics or permission. 3 cr.

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

857. Coastal Engineering and Processes
Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as ME 857 and OE 857.) 3 cr.

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

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

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 compaction, reinforcement, geosynthetics, slurry trenches, grouting, subsurface drainage, and admixtures. Prereq: CIE 860; CIE 861. 3 cr.

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

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

882. Timber Design
Properties and characteristics of structural woods, mechanics of wood, connection methods, design of timber members, and connections in beams, columns, and trusses, and glued laminates of wood. Prereq: structural design concepts or permission. 3 cr.

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

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

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

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

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

893. Structural Design in Steel
The design of members and connections: tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Introduction to plastic design of beams and frames. Prereq: structural analysis or permission. 4 cr.

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

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

922. Highway and Airport Engineering
Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prereq: CIE 821 or permission. 2–4 cr.

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

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

mission 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 water and wastewater 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, particle-liquid separation, dissolved organic and inorganic constituent removal, and disinfection unit processes. Knowledge of research literature stressing recent advances and applications is required. Prereq: CIE 849; CIE 943/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: groundwater 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.

958. Topics in Environmental Engineering
Selected topics in specialty areas of environmental engineering not ordinarily included in other courses. May involve formal classes, seminars, discussions, laboratory work, or independent investigations. Prereq: permission. May be repeated up to 8 cr. 2–4 cr.

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

961. In Situ Geotechnical Testing
In situ geotechnical testing methods for site characterization; theory and practice. The geotechnical methods include the piezocone, the pressuremeter, the dilatometer, the field vane, and the standard penetration test. Sampling techniques. Geophysical exploration. Prereq: CIE 960 or equivalent. 3 cr.

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

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

967. Soil Dynamics
Vibrations of elementary systems, wave propagation, elastic waves in layered systems, behavior of dynamically loaded soils, vibrations of foundations, isolation of footings, field measurements and instrumentation, design procedures for dynamically loaded foundations. Prereq: CIE 865; CIE 863;/or permission. 3 cr.

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

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

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

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

983. Structural Stability
Study of the elastic and inelastic buckling behavior of structures. Topics include stability of columns, mathematical treatment of buckling problems and buckling criteria, lateral stability of beams, buckling of trusses and framed structures, and stability of rings and curved beams. 4 cr.

984. Dynamics of Structures
Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one- and multi-degrees of freedom. Vibrations of curved beams, multistory frames, and plate structures. Prereq: CIE 885 or permission. 4 cr.

985. Application of System Theory to Structural Analysis
Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 cr.

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

995, 996. Civil Engineering Problems
The study and investigation of problems selected to meet the needs of the students. 2–4 cr.

899. Master's Thesis
6–9 cr.

999. Doctoral Research

Communication Disorders (COMM)

Chairperson: Frederick C. Lewis
Associate Professors: Stephen N. Calculator; Frederick C. Lewis
Adjunct Associate Professors: Linda Hanrahan; Frederick P. Murray
Assistant Professors: Stephen P. Bornstein; Susan Dietrich; Penelope E. Webster
Adjunct Assistant Professor: Richard Guare; Karen Lucas
Graduate Program Coordinator: Stephen N. Calculator

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-Aged 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 upon 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 amplication 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 upon 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.

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

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

920. Graduate Seminar
Current topics, recent investigations, and library research. (May be repeated up to 9 credits barring duplication of subject matter.) 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: Ted Martin Sparr
Professors: R. Daniel Bergeron; Shan S. Kuo; Ted Martin Sparr
Associate Professors: Eugene C. Freuder; Robert D. Russell; James L. Weiner
Adjunct Associate Professor: Sylvia Weber Russell
Assistant Professors: Pilar de la Torre; Raymond Greenlaw; Philip J. Hatcher; 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 are expected to have studied high-level language programming, assembler-language programming, data structures, analysis of algorithms, operating system fundamentals, programming language concepts, and discrete mathematics. Further experience in computer science, mathematics, and/or electrical engineering will also be expected. All applicants must submit general and subject test scores from the Graduate Record Examination.

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

M.S. Degree Requirements

The student may choose to follow a depth-oriented program with a thesis or a breadth-oriented program without a thesis. Both options require the completion of CS 901 and CS 900 (a 1-credit graduate seminar). The thesis option requires seven additional courses numbered 800 or above (three must be above 901), plus 6 credits of thesis work. The nonthesis option requires nine additional courses numbered 800 or above (four must be above 901), plus comprehensive examinations covering the two broad areas: systems and theory.

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

Ph.D. Degree Requirements

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

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

Every doctoral student must pass a written qualifying exam consisting of two major components: a breadth requirement and a depth requirement. The breadth requirement includes both course requirements and written examination consisting of fundamentals and systems components. The depth requirement of the qualifying examination 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, nontrivial 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: CS 822 or permission. 3 cr.

820. Operating System Concepts
Theory and practice of building operating systems. In-depth investigation of operating system concepts and design. Developments from current operating systems (e.g., UNIX, DOS, OS/2). Examples from industry are emphasized. Prereq: operating systems fundamentals or equivalent. 4 cr.

822. Advanced Systems Programming
Topics in systems programming, including organization and implementation of assemblers, linkage editors, job schedulers, command language decoders. File systems, protection, security, performance evaluation, and measurement. Prereq: operating system fundamentals and assembly language programming and machine organization. 3 cr.

827. Computer Communications Software Design
Telecommunications software. Error detection algorithms. Asynchronous and synchronous communications software. Network architectures. Protocol definition and implementation. Links through a local area network. Timing considerations. Implementation of selected communications software. Prereq: operating system fundamentals. 3 cr.

830. Introduction to Artificial Intelligence
Machine intelligence, representation and control issues, search methods, problem solving, learning computer vision, natural language understanding, knowledge engineering, game playing. Heuristic programming and the LISP language. Prereq: prog. lang. concepts and features. 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. Semantic Issues in Natural Language Processing
Introduction to computational analysis of natural language, with a focus on semantic issues. Syntax and formal grammars, parsing, semantic representations, inference, memory. Ambiguity, metaphor, noun groups. Prerequisites: elementary knowledge of a programming language such as LISP or PROLOG, or permission. 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: intro. to computer science or data structures and algorithms. 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 and either intro. to computer science or data structures and algorithms. 3 cr.

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

901. 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.

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: EE 812 or equivalent; CS 822. 3 cr.

930. Artificial Intelligence
Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. 3 cr.

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

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

958. Automata Theory
Formal language and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as EE 958.) 3 cr.

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.

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

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

975. Database Systems
Access control techniques; access strategies; database software; database-related languages; data translation techniques; recovery and restart; restructuring; concurrent access methods; very large databases; performance and evaluation; protection and security. Prereq: CS 822 or permission. 3 cr.

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

980. Advanced Topics in Computer Science
3 cr.

981. Advanced Topics in Database Systems
3 cr.

983. Advanced Topics in Artificial Intelligence
3 cr.

984. Advanced Topics in Computer Science Theory
3 cr.

985. Advanced Topics in Operating Systems
3 cr.

987. Advanced Topics in Computational Linguistics
3 cr.

989. Advanced Topics in Algorithms
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, 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 thermostasis; long-term effects of major human perturbations (greenhouse warming of the atmosphere, ozone depletion, deforestation, desertification, and biotic and soil impoverishment) and human-environment feedback mechanisms on the viability of the Earth versus the survival of the human species; effectiveness of existing and alternative national, regional, and international institutions in responding to global change. Prereq: permission. 3 cr.

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

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

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

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

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 will 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, ocean, and space science and engineering, students are expected to contribute to a discussion of current topics of interest in the literature. 3 cr.

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

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

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
Research Associate Professors: Mark E. Hines; Robert W. Talbot
Adjunct Associate Professors: David A. Gust; William Berry Lyons; Neal R. Pettigrew
Assistant Professor: Mark A. Person
Research Assistant Professors: Patrick M. Crill; Jack E. Dibb; Julie M. Palais; Mary Jo Spencer; Larry G. Ward
Graduate Program Coordinator: Francis S. Birch

Degrees Offered

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

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

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

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

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

Admission Requirements

An applicant is expected to have completed one year each of college chemistry, physics, and calculus; to have an undergraduate major or equivalent in geology, chemistry, physics, mathematics, engineering, or the biological sciences; and to present scores from the general test of the Graduate Record Examination. Students lacking some background in a particular area may be admitted provided they are prepared to complete courses, without graduate credit, in which they may be deficient. The program of study (geology, hydrology, oceanography, or geochemistry) a student wishes to follow as well as the student's undergraduate major determines the level of necessary preparation. The preparation of each student is determined before the beginning of the first semester in residence in order to plan the course of study. Each entering student is assigned an academic adviser who assists the student in planning a program of study.

Normally, students are required to have completed a master's degree before entering the Ph.D. program.

M.S. Degree Requirements

Students in the M.S. programs are required to complete the core curriculum for their respective area. A minimum of 30 credits, which may include the credits accumulated in the core curriculum, must be completed satisfactorily. Eight credits must be taken at the 900 level. Students must complete a master's thesis and give an oral presentation of the results. All students are required to participate in the instructional activities of the department.

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

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

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

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

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

Ph.D. Degree Requirements

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

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

803. Fluvial Hydrology
Mechanics of flows in the hydrologic cycle. Natural open-channel flows: forces, energy principles, velocity profiles, flow resistance, erosion and sediment transport, alluvial channel form, computation of flow profiles, weirs, hydraulic jumps, complete equations for streamflow routing. Principles of porous-media flows: Darcy's law, soil physics, complete equations for ground-water and soil-water flow. Prereq: one year each of calculus and physics. Lab and field exercises. 4 cr.

805. Principles of Hydrology
Physical principles important in the hydrologic cycle, including basic equations, properties of water, movement of water in natural environments, formation of precipitation, relations between precipitation and streamflow, snow-melt, evapotranspiration, interception, infiltration, relations between groundwater and streamflow, and hydrologic aspects of water quality. Problems of measurement and aspects of statistical treatment of hydrologic data. Transportation fee. Prereq: one year each of calculus and physics. Lab. 4 cr.

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

810. Groundwater Hydrology
Principles for fluid flow in porous media with emphasis on occurrence, location, and development of groundwater, but with consideration of groundwater as a transporting medium. Major topics include well hydraulics, regional groundwater flow, exploration techniques, and chemical quality. Laboratory exercises involve use of fluid, electrical, and digital computer models to illustrate key concepts. Prereq: ESCI 805 or permission. Lab. 4 cr.

825. Igneous Petrology
The origin, formation, and geologic history of igneous rocks as determined from field and laboratory studies of occurrences, mineral assemblages, rock composition, and texture. Interpretation of rock and mineral compositional diagrams; application of experimental investigations. Prereq: optical mineralogy and petrography. Field trips. Lab. 4 cr.

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

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

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

841. Geochemistry
Thermodynamics applied to geologic processes; geochemical differentiation of the earth; the principles and processes that control the distribution and migration of elements in geological environments; stable and radiogenic isotopes in geologic processes. Prereq: one year of mineralogy or permission. 4 cr.

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

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

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

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

852. Chemical Oceanography
Water structure, chemical composition and equilibrium models; gas exchange; biological effects on chemistry; trace metals and analytical methods. Laboratory includes short cruise abroad R/V *Jere A. Chase*. Prereq: permission. Lab (optional). 3 or 4 cr.

853. Geolimnology
Geological and geochemical aspects of lake systems, including formation of lake basins, water budgets, sediment derivation and dispersal,

biogeochemical interactions in the water column and sediments, sedimentary record of lakes, chemical sedimentation in brackish and saline lakes, as well as lake sediments in the geologic record. 3 cr.

854. Modern Sediments
Examines recent sediments from their source area to the depositional environment. Emphasis on the shallow water clastic sediments and their characteristic properties. The weekly laboratory 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 an in-depth 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 or 4 cr.

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

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

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

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 ground water. Term project to be selected and implemented by each student. Prereq: physical chemistry; geochemistry, or soil chemistry or equivalent; computer methods; hydrology or limnology;/or permission. 3 cr.

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

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

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

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

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

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

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

954. Advanced Sedimentation
Extensive readings and discussions of original sources and relevant literature dealing 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 will be treated in detail. Prereq: ESCI 858; ME 807;/or permission. 3 cr. (Not offered every year.)

959. Data Analysis Methods in Ocean and Earth Sciences
Methods of analysis of oceanographic, geophysical, geological, and environmental data. Introductory tutorial on important mathematical concepts precedes the development of the bases for a number of data analysis techniques; digital filtering, regression analysis, cross-spectral analysis, objective analysis, and elementary inverse theory, etc. Students use these techniques on real data. Prereq: differential equations or equivalent. 4 cr.

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

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. (May be taken more than once.) 1–4 cr.

997, 998. Seminar in Earth Sciences
A review and discussion of recent literature in the earth sciences. Required of graduate students in earth sciences. 1–3 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research

Economics (ECON)

Chairperson: Allen R. Thompson
Professors: Robert C. Puth; Evangelos O. Simos; Dwayne E. Wrightsman
Associate Professors: Richard W. England; Marc W. Herold; Richard L. Mills; Neil B. Niman; Adrienne McElwain Steiner; Allen R. Thompson; James R. Wible
Adjunct Associate Professors: Ralph B. Bristol, Jr.; Evangelos Charos
Assistant Professors: W. David Bradford; Karen Smith Conway; Bruce T. Elmslie; Michael D. Goldberg; Torsten Schmidt

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.

Admission Requirements

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

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

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

M.A. Degree Requirements

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

1. At least 30 total semester hours, which may include 8 hours of thesis;
2. Of the total hours:
   a. a minimum of 12 hours *must* be in 900-level courses. Two of these courses must be ECON 972 (Macroeconomics I) and ECON 976 (Microeconomics 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;
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 other 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, environmental impact of technology transfer to less-developed nations. Prereq: intermed. microecon. and macroecon. analysis or permission. 4 cr.

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

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

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

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

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. 3 cr. (Also offered as ADMN 842).

835. Economics of Financial Markets
Economic analysis of financial market systems. Topics include financial market functions, theories of saving and investment, financial intermediation, flow-of-funds analysis, loanable funds theory, interest rate forecasting, portfolio theory, capital-asset pricing models, structure of interest rates (including term-structure theory), and macroeconomic models of the financial sector. Prereq: money and banking or permission. 4 cr.

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

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. Prereq: international econ. or permission. 4 cr.

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

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

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

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

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

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

868. Seminar in Economic Development
An advanced reading seminar. Topics include methodologies underlying economic development theory, industrialization and post-import substitution, state capitalist development, stabilization policies, appropriate technologies, the capital goods sector, agricultural modernization schemes, and attempts at transition to socialism. Prereq: permission. 4 cr.

869. Case Studies in Economic Development
A) Southeast Asia; B) Cost-Benefit and Project Analysis; C) Africa; D) Latin America; E) Middle East. Problems and policies in selected countries; evaluations of national plans, programs, and projects; comparative analysis. Prereq: prin. of econ. or permission. 4 cr.

874. Economic Dynamics
Use of difference and differential equations for analysis of dynamic properties of single-equation and system-wide models in micro and macro economics. 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, Keynes' *General Theory*, Keynesian, Monetarist, New Classical, and New Keynesian models and views. An introduction to open economy macro models. 4 cr.

973. Macroeconomics II
Theory, empirical specification, and tests of macroeconomic functions. National econometric models. Theories and empirical models of the business cycle and economic growth. Use of models for policy analysis and forecasting. Prereq: Macroeconomics I, Econometrics I. 4 cr.

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 noncooperative 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
1-6 cr.

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

899. Master's Thesis
8 cr.

999. Doctoral Research

Education (EDUC)

Chairperson: Bruce L. Mallory
Professors: Michael D. Andrew; Angelo V. Boy; Donald H. Graves; David J. Hebert; 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; Jane A. Hansen; Barbara Houston; Judith A. Kull; Bruce L. Mallory; Jane E. Nisbet; Sharon N. Oja; M. Daniel Smith; William L. Wansart; Dwight Webb
Adjunct Associate Professor: Richard H. Goodman

Assistant Professors: Richard Barton; Todd DeMitchell; Nancy E. Ellis; Virginia E. Garland; Georgia Kerns; Rebecca S. New; Joseph J. Onosko; Pearl M. Rosenberg; Thomas H. Schram
Graduate Program Coordinator: Susan D. Franzosa

Degrees Offered

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

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

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

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

Admission Requirements

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

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.

Doctor of Philosophy in Education

Program Information: Grant Cioffi

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 advisors, 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; focused 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 current 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

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; one course selected from the special needs option courses offering (EDUC 860, 947, 951, 952, 955, or 956); and two semesters (6 credits) of internship in EDUC 900B and 901B.

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.

Special Needs Option In addition to the early childhood core requirements described above, students choosing this option will concentrate on young children who are at risk for or have developmental difficulties and special needs. Coursework emphasizes an understanding of the role of the family, community, and social policy in early development and intervention. The program is noncategorical in its approach to assessment and educational planning.

Core Requirements (38 credits): identical to core requirements of early childhood program with addition of 860, Introduction to Young Children with Special Needs; 947, Curriculum for Young Children with Special Needs: Evaluation and Program Design; and 949, Supporting Parents of Young Special Needs Children.

Electives (4 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.

Reading

Program Information: John Carney, Grant Cioffi, Jane Hansen

The Department of Education offers the master of education degree in reading. This program provides professional training for individuals seeking certification as reading specialists: 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 (6 credits): 938, Advanced Seminar in Special Education; 981, Methods and Techniques of Educational Research.

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

Concluding Experience: All degree candidates must 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) 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. [The middle 50 percent of students admitted to all graduate programs in teacher education during the years 1988 to 1990 scored between 500 and 590 on the verbal section of the GRE, 460 to 610 on the quantitative section, and 510 to 640 on the analytical section. They also had an average undergraduate grade-point average between 2.84 and 3.34.]

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 four credits or an equivalent in each of the following: 500, Exploring Teaching; 800, Educational Structure and Change; 801, Human Development and Learning: Educational Psychology; 803, Alternative Teaching Models; 805, Alternative Perspectives on the Nature of Education; 900A, 901A, Internship and Seminar/ Teaching (6 credits each).

Elementary teacher 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 licensure 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; 953, Seminar in Curriculum Study; 983, Advanced Psychology of Human Learning; 984, Advanced Human Development; 986, Philosophy of Education; and SOC 938, Sociology of Education: Social Organization of Schools and Community.

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

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

800. Educational Structure and Change
A) Educational Structure and Change; B) Education in America: Backgrounds, Structure, and Function; C) Governance of American Schools; D) School and Cultural Change; E) Teacher and Cultural Change; F) Social Perspectives of Conflict in the Schools; G) Nature and Processes of Change in Education; H) What Is an Elementary School?; I) Schooling for the Early Adolescent; J) Children with Special Needs: History and Models; K) Curriculum Structure

and Change; L) Stress in Educational Organizations. Organization, structure, and function of American schools; historical, political, and social perspectives; nature and processes of change in education. Two- and 4-credit courses offered each semester (listed in department; refer to *Time and Room Schedule*). Minimum of 4 credits required for teacher 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 4-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 course 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; I) Education as a Form of Social Control; K) Schooling and the Rights of Children; L) Education, Inequality, and the Meritocracy; M) Readings in Philosophies of Outdoor Education; N) Alternative Perspectives on the Nature of Education; O) Classrooms: The Social Context; P) Teaching: The Social Context; Q) School and Society. Students formulate, develop, and evaluate their own educational principles, standards, and priorities. Alternative philosophies of education; contemporary educational issues. Two- and 4-credit courses offered each semester (listed in department; refer to *Time and Room Schedule*). Minimum of 4 cr. required for teacher 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.

842. The Young Gifted Child
Identification and teaching of young gifted children (preschool through primary). Considers historical perspectives, issues, exemplary models of gifted education, multiple teaching strategies, and relevant materials. Of interest to pre-service and in-service teachers, parents, and advocates for the gifted. 4 cr.

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

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

852. Diagnosis and Remediation of Learning Disabilities
Terminology, etiology, common characteristics, and symptoms; theory and practice in gross-motor, visual, and auditory remediation; testing procedures used in diagnosis and remediation programs. 4 cr.

853. Children with Behavior Disorders
Nature and scope of emotional disturbances and social maladjustments in children, including causes, characteristics, treatment implications, and educational problems. 4 cr.

854. Survey of Developmental Disabilities
The causal factors, physical and psychological characteristics, and educational and therapeutic implications of mental retardation, cerebral

palsy, epilepsy, autism, and related handicapping conditions. Observations of programs and services for the developmentally disabled are required. 4 cr.

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

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

876. Reading for Children with Special Needs
Techniques and procedures for teaching reading to children with special learning needs: the mentally retarded; learning disabled; gifted; culturally diverse. Emphasis will be placed on the implications of providing reading instruction in the least restrictive alternative. 4 cr.

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

885. Educational Tests and Measurements
Theory and practice of educational evaluation; uses of test results in classroom teaching and student counseling; introductory statistical techniques. 4 cr.

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

897. Seminar in Contemporary Educational Problems
Issues and problems of special contemporary significance, usually on a subject of recent special study by faculty member(s). Prereq: permission. May be repeated for different topics. 4 cr.

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

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

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

918-919. Seminar on Research in Reading/Writing Instruction
(1) Examines the 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 upon the concepts and processes of adaptation. 4 cr.

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

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

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

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

929. Advanced Counseling Internship
Supervised application of advanced counsel-

ing theory and practice in counseling relationships. Samplings of the advanced counseling practices of students are analyzed and evaluated. Prereq: permission. 4 cr.

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

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

932. Administration and Professional Issues in Counseling
Organizational patterns and administrative procedures that influence the effectiveness of counseling services. Emphasis upon staff development, accountability, professional issues, and productive supervisory behaviors. Prereq: permission. 4 cr.

935. Seminar and Practicum in Secondary School Teaching
Supervised Practicum: An exploratory summer practicum in a local summer high school to examine teaching as a career and to prepare for the internship in the fall. Summer includes (1) a prepracticum workshop focusing on interpersonal skill development; (2) a prepracticum curriculum and instruction laboratory; (3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer 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 development; (2) a prepracticum curriculum and instructional laboratory; (3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; (4) seminars in curriculum and instruction. Opportunities for teaching high school students are available for candidates who wish to determine better what level of teaching they prefer. Prereq: admission to the Live, Learn, and Teach program. 4 cr. (Summer Session only.)

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

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

941. Child Development for the Early Childhood Professional I
Focus on typical child development from birth to age eight. Consider 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 handicapping condition. Issues include diagnosis and prognosis for the child, parent-child attachment, and interactions with other care givers. Counseling and support techniques. 4 cr.

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 will be on Public Law 94-142. The role of policy making and constitutional and ethical issues will be discussed. 4 cr.

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

953. Seminar in Curriculum Study
Analysis of recent trends in public school curriculum; structures, philosophy, development, change, and evaluation. Primarily for experienced teachers and administrators. Prereq: teaching experience. 4 cr.

955. Teaching Students with Mental Retardation
Application of theory and research in the field of mental retardation to classroom teaching: functional curriculum design, behavioral and instructional strategies, program development, integration of related services, and pre- and

post-school transition planning. Prereq: EDUC 854 or permission. 4 cr.

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

958. Analysis of Teaching
Comparative analysis of current techniques and instrumentation for studying the process of teaching in the classroom. Consideration of substantive and procedural issues involved in planning for teaching. Prereq: teaching experience. 4 cr.

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

961. Public School Administration
Introductory course; major issues 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 will be part of the project work. Prereq: EDUC 961. 4 cr.

963. Seminar in Educational Administration
Cases and concepts in decision making, motivation, job satisfaction, 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 will be given to collective bargaining statutes, case law, employee relations boards, unit determinations, exclusive representation, union security provisions, scope of bargaining, good faith, grievance procedures, bargaining strategies, strikes, public interest, mediation, fact finding, arbitration, and the administration of the negotiated contract. Prereq: EDUC 963. 4 cr.

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

970. The Change Process in Education
Role of change agent and the change process in education as related to school personnel; structural characteristics of the school culture; change theory and systems analysis techniques. Students are required to apply some of the theories in an institutional setting. 4 cr.

971. School Facilities Management
Techniques and procedures involved in the long-range planning of school facilities: for example, school 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 961;/or permission. 4 cr.

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

974, 975. Administrative Internship and Field Project
Field-based internship. Administrative 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) will be given upon successful completion of the internship and field project. 6 cr.

980. Research in the Teaching of Writing
Review of the last 30 years of research in writing, focusing on trends in design, research procedures, the contributions of linguistics, cognitive and developmental psychology, with a view to the conduct of research by participants. Prereq: permission. 4 cr.

981. Methods and Techniques of Educational Research
Conceptual aspects and practical realities of the research process applied to problems in education and human service disciplines. Develops skills necessary to use as well as conduct research. 4 cr.

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.

990. Developmental Perspectives on Adulthood
Research and theory about critical life issues; developmental tasks of the life cycle; periods of transition; stages of intellectual, moral, and personality development of the adult; and the design of significant learning experiences for adults within a variety of educational settings and institutions. Prereq: permission. 4 cr.

995. Independent Study in Education
Opportunity for intensive investigation of a special problem or issue in the field of education. Prereq: permission. 1–4 cr. May be repeated to a maximum of 8 cr.

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

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

999. Doctoral Research

Electrical and Computer Engineering (EE)

Chairperson: John L. Pokoski
Professors: Ronald R. Clark; Albert D. Frost; Glen C. Gerhard; 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: Kent C. Chamberlin; Allen D. Drake; Donald W. Melvin; Richard A. Messner; Paul J. Nahin; Andrzej Rucinski
Adjunct Associate Professor: Stuart M. Selikowitz
Assistant Professor: Michael J. Carter
Adjunct Assistant Professor: Benjamin H. Hoffman
Graduate Program Coordinator: Richard A. Messner

Degree Offered

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

The department offers studies leading to specialization in the following major areas: biomedical engineering, communication systems and information theory, computer engineering and digital systems, image processing and pattern analysis, control and systems engineering, fiber optics, electromagnetics, geophysical sensing and propagation, illumination engineering, and ocean engineering and instrumentation.

Admission Requirements

An applicant should have completed a baccalaureate degree in electrical engineering or have comparable training, which included courses in mathematics and physical science, network theory, digital systems, fields and waves, electronics, solid state circuits, semiconductor device theory, with appropriate laboratory experiences.

M.S. Degree Requirements

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

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

In addition to taking advanced coursework, master's students must demonstrate their ability to do independent work and report their results. This can be done in either of two ways: (1) a minimum of 24 credits of coursework plus 6 credits of thesis (EE 899) or (2) a minimum of 27 credits of coursework plus a 3-credit, one-semester project (EE 995). With the consent of the graduate committee, a student who has demonstrated the ability to do independent work through sufficient industrial experience may substitute an approved course for EE 995.

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

804. Electromagnetic Fields and Waves II
Loop antennas; aperture and cylindrical antennas; self and mutual impedance; receiving antennas and antenna arrays; bounded plane waves; rectangular and cylindrical waveguides; waveguide discontinuities and impedance matching; solid state microwave sources. Prereq: electromag. fields and waves I. 4 cr.

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

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

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

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

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

841. Nonlinear Systems Modeling
Modeling of hydraulic, pneumatic, and electromechanical systems. Solution methods including linearization and computer simulation of nonlinear equations. Methods of generalizing the nonlinear models for design purposes are developed. (Also offered as ME 841.) 4 cr.

845. Fundamentals of Acoustics
Acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics and measurement of acoustical sources; human perception of sound, loudness, intensity; microphones; acoustical materials; problems in environmental sound control; ultrasonics; architectural acoustics. Prereq: general physics II; differential equations. Lab. 4 cr.

857. Fundamentals of Communication Systems
Discussions of deterministic signals, Fourier spectra, random signals and noise, baseband communication, analog and digital modulation schemes, and system signal to noise ratio. Prereq: probability and discreet systems. Lab. 4 cr.

858. Communication Systems
Design of high-frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free-space propagation, propagation characteristics of the ionosphere. Prereq: electromag. fields and waves I; EE 857 or equivalent. Lab. 4 cr.

860. Introduction to Fiber Optics
Basic physical and geometric optics, solution of Maxwell's equations for slab waveguides and cylindrical waveguides of both step-index and graded-index profiles, modes of propagation and cutoff, polarization effects, group and phase velocity, ray analysis, losses, fabrication, sources, detectors, couplers, splicing, cabling, applications, system design. Prereq: physics; differential equations with linear algebra; electricity and magnetism or electromagnetic fields and waves. Lab. 4 cr.

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

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

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

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

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

875. Applications of Integrated Circuits
Design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Limitations and use of operational amplifiers. Laboratory course in practical applications of nondigital integrated circuit devices. Prereq: advanced electronics. Lab. 4 cr.

881. Physical Instrumentation
Analysis and design of instrumentation systems. Sensors, circuits, and devices for measurement and control. Elements of probability and statistics as applied to instrument design and data analysis. Transmission, display, storage, and processing of information. The design, implementation, testing, and evaluation of an instrument system is an integral part of the course. (Also offered as OE 881.) 4 cr.

884. Biomedical Instrumentation
Principles of physiological and biological instrumentation design including transducers, signal conditioning, recording equipment, and patient safety. Laboratory includes the design and use of instrumentation for monitoring of electrocardiogram, electromyogram, electroencephalogram, pulse, and temperature. Current research topics, such as biotelemetry, ultrasonic diagnosis, and computer applications. Lab. Prereq: human anatomy and physiology or equivalent; advanced electronics. 4 cr.

885. Underwater Acoustics
Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small- and large-signal considerations. (Also offered as OE 885.) 4 cr.

887. Analysis and Design of Human Physiological Control Systems
Analysis and design of human physiological control systems and regulators through mathematical models: Identification and linearization of system components. Membrane biophysics. Design of feedback systems to control physiological states through the automatic administration of drugs. System interactions, stability, noise, and the relation of system malfunction to disease. Prereq: 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; wave guides; simple resonators; elements of microwave circuits, linear and aperture antennas, arrays of dipoles; receiving antennas. Prereq: electromag. fields and waves I or equivalent. 3 cr.

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

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

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

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

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

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

939. Statistical Theory of Communications
Introduction to probability theory and random waveforms leading to a discussion of optimum receiver principles. Topics include random variables, random processes, correlation, power spectral density, sampling theory, and optimum decision rules. 3 cr.

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

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

942. Discontinuous Control
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers, and limit cycle behavior of quantized systems are developed. (Also offered as ME 942.) 4 cr.

944. Nonlinear Control Systems
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: EE or ME 951. (Also offered as ME 944). 4 cr.

951. Advanced Control Systems I
State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer controlled systems (sampling, discrete state representation, hybrid systems), nonlinear analysis (Liapunov, Popov, describing function). Prereq: EE or ME 872. (Also offered as ME 951.) 3 cr.

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

955. Estimation and Filtering
Stochastic systems course with application to control and communications. Topics include random variables, noise in linear systems, Bayesian and minimum variance estimation theory, optimal state estimators, Wiener and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: ME or EE 951; MATH 835 or equivalent. (Also offered as ME 955.) 3 cr.

958. Automata Theory
Formal languages and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. (Also offered as CS 958.) 3 cr.

960. Computer Architecture
Advanced topics in computer organization. Parallel and pipeline processing; associative and stack computers; microprogramming; virtual memory; current topics. Prereq: logical design of digital computers. 3 cr.

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

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

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

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

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

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 adviser. A written report is required, as is an oral examination on the work and related subjects. 3 cr.

998. Independent Study
Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1–3 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research

Engineering Ph.D. Program (ENGR)

Coordinator: Donald W. Melvin

Degree Offered

The College of Engineering and Physical Sciences offers a program of study leading to the degree of doctor of philosophy in engineering. The program has five areas of specialization: chemical engineering, civil engineering, electrical engineering, mechanical engineering, and systems design.

The systems design area is an interdepartmental program that addresses contemporary engineering and scientific problems that can be solved only through the cooperation of a variety of disciplines. Students in systems design can elect either one of two professional directions. The first develops professionals with the technical expertise of a Ph.D. and with the ability to work with and direct groups of people working on large-scale technical projects. The second direction develops engineers with capabilities in the theory and analysis of large-scale complex systems. Concentration in an area of specific individual interest is combined with participation in a larger interdisciplinary project.

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

Chemical Engineering: Stephen S. T. Fan, area coordinator.
Civil Engineering: Jean Benoit, area coordinator.
Electrical Engineering: Richard A. Messner, 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 stu-

dents 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; Burt H. Feintuch; Lester A. Fisher; Elizabeth H. Hageman; Robert Hapgood; Jean E. Kennard; Andrew H. Merton; Thomas R. Newkirk; Philip L. Nicoloff; Susan Schibanoff; Charles D. Simic; Mark R. Smith; John A. Yount
Associate Professors: Janet E. Aikins; Robert J. Connors; Michael K. Ferber; Melody G. Graulich; Jane T. Harrigan; Rochelle Lieber; Mekeel McBride; Patrocinio P. Schweickart; Sarah Way Sherman; David H. Watters
Assistant Professors: Brigitte Gabcke Bailey; Eric O. Clarke; Susan M. Hertz; Romana C. Huk; James Krasner; Douglas M. Lanier; John S. Lofty; Lisa W. MacFarlane; Ramachandran Sethuraman; Sandhya Shetty; Patricia A. Sullivan; Rachel Trubowitz
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 departmental guidelines. 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 doctor of philosophy degree program must also submit scores for the subject test of literature in English. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language. A student admitted to the Ph.D. program must hold an M.A. degree or be in the final stage of completing requirements for the degree.

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

Master of Arts Degree Requirements

Literature Option An M.A. candidate must complete 32 credit hours at the 800 or 900 level including at least two seminar courses and 4 credits of English 998. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literatures). Each M.A. candidate must pass the master's seminar in the study of literature (ENGL 925) and one course in the English language or in the teaching of composition. As a general rule, all courses counting toward the M.A. degree should be taken in the English department. In special circumstances, however, a student may be allowed to apply toward the degree up to two graduate courses offered by other departments. For students planning a teaching career, the department requires at least one semester of teaching experience (subject to availability of funds).

An M.A. candidate must pass a reading examination in a foreign language. Foreign students whose native language is not English may be exempt from this requirement. Each candidate for the M.A. degree must register for 4 credits of ENGL 998 and produce a substantial scholarly paper.

Writing Option The master of arts in writing is designed for students who intend to become professional writers. Eight working writers supervise the program. Students may elect to specialize in fiction, nonfiction, or poetry. Each member of the writing faculty is accomplished in at least one of these fields.

The writers at UNH emphasize conference teaching. Each student meets frequently with writers specializing in the student's area of study. In addition, each student works closely with a writer-adviser throughout the program.

Workshop courses provide forums for prompt, detailed criticism of each student's writing by instructors and fellow students. Each student takes at least two workshops in his or her specialty and may elect to take an additional workshop in another area as well. Form-and-theory courses and literature courses complete the program. The program consists of 32 credit hours at the 800 or 900 level.

Upon completion of the required courses, the student submits a portfolio of writing to the staff. The portfolio might consist of short stories, a novel, nonfiction articles, nonfiction book, or a collection of poetry. The degree is awarded upon approval of the portfolio by a committee of writers. There is no foreign language requirement.

English Language and Linguistics Option Students who wish to specialize in any of the various areas of English language and linguistics may design an M.A. program to meet their interests. Specialties include applied linguistics and the teaching of English as a second language as well as the traditional subfields of linguistics. Psycholinguistics courses are offered through the psychology department.

To earn the M.A. degree, students must complete at least 32 credit hours at the 800 or 900 level, including one seminar course, and 4 credits of ENGL 998 in which they are to produce a substantial scholarly paper. Unless the student already has a strong background in linguistic theory, the program of study must include one course in phonetics and phonology (ENGL 893) and one in syntax and semantics (ENGL 894). Reading knowledge of one foreign language is required. The student's course of

study must be approved by the program adviser.

Master of Science for Teachers Degree Requirements

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

Ph.D. Degree Requirements

The Ph.D. program offers professional training in literature, language, and the teaching of composition. The program combines the essential guidance and discipline of coursework with the equally essential freedom of independent study and research. Accordingly, in the first year the student is encouraged to follow a program suited to individual interests and needs.

Ph.D. candidates normally complete ten English courses beyond the M.A. degree. Four of these courses must be graduate seminars in this department. The other courses should be at the 800 or 900 level and must include: Introduction to the Teaching of Writing (ENGL 810); a course on criticism; a half-course (2-credit) ungraded module on the teaching of literature (ENGL 920); and a half-course (2-credit) ungraded module on bibliography and professional methods (ENGL 924). In special circumstances, a course from another department may be included among the ten courses with approval of the graduate committee.

In addition to meeting course requirements, each student must pass (1) reading examinations in two foreign languages; 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.

See English department brochure for detailed descriptions of current course offerings.

600. English as a Second Language
A course designed for foreign graduate students in their first semester at UNH to give them English language skills necessary for effective graduate work at the University. Includes work on listening skills (understanding lectures, note-taking, etc.), reading skills, the writing of research papers, the making of oral reports, and general study skills, with work on grammar and pronunciation for those who need it. Credits may not be used to fulfill minimum degree requirements of a graduate program. 2–4 cr. Cr/F. (May be repeated.)

803, 804. Advanced Nonfiction Writing
A workshop course for students intending to write publishable magazine articles or nonfiction books. Equal stress on research and writing techniques. Prereq: newswriting; written permission of instructor required. May be repeated for credit with the approval of the department chairperson. 4 cr.

805. Advanced Writing of Poetry
Workshop discussion of advanced writing problems and submitted poems. Individual conferences with instructor. Prereq: writing poetry or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

807. Form and Theory of Fiction
A writer's view of the forms, techniques, and theories of fiction. The novels, short stories, and works of criticism studied vary, depending on the instructor. 4 cr.

808. Form and Theory of Nonfiction
A writer's view of contemporary nonfiction, emphasizing the choices the writer faces in the process of research and writing. 4 cr. (Not offered every year.)

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

810. Teaching Writing
An introduction to various methods of teaching writing. Combines a review of theories, methods, and texts with direct observation of teaching practice. 2–6 cr.

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 influence or even determine the choice of methods of language teaching. Research on second language acquisition and bilingualism, language aptitude, and the cultural context of language acquisition. Includes an introduction to standard and exotic methods of language teaching. 4 cr.

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

818. English Linguistics and Literature
An introduction to linguistics for students of literature. Includes a survey of the grammar of English (phonology, morphology, syntax, dialect variation, historical change) with application to the analysis of the language of poetry and prose. 4 cr. (Not offered every year.)

841. Literature of Early America
Prose and poetry of the periods of exploration, colonization, early nationalism, Puritanism, Enlightenment. Individual works and historical-cultural background. 4 cr. (Not offered every year.)

842. American Literature, 1815–1865
Fiction, nonfiction, and poetry in the period of romanticism, transcendentalism, nationalism. Individual works and cultural background. 4 cr. (Not offered every year.)

843. American Literature, 1865–1915
Fiction, nonfiction, and poetry in the period of realism, naturalism, industrialism, big money. Individual works and cultural background. 4 cr.

844. American Literature, 1915–1945
Fiction, poetry, and drama in the period of avant-garde and leftism, jazz age, and depression. Individual works and cultural background. 4 cr.

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

846. Studies in American Drama
Topics vary from year to year. Examples: 20th-century American drama; contemporary playwrights; theatricality in American life. 4 cr. (Not offered every year.)

847. Studies in American Poetry
Topics vary from year to year. Examples: poets of the open road; Pound and his followers; major American poets; contemporary American poetry. 4 cr. (Not offered every year.)

848. Studies in American Fiction
Topics vary from year to year. Examples: the romance in America; the short story; realism and naturalism; the city novel; fiction of the thirties. 4 cr.

849. Major American Authors
Intensive study of two or three writers. Examples: Melville and Faulkner; Fuller, Emerson, and Thoreau; James and Wharton; Dickinson and Frost. 4 cr.

850. Special Studies in American Literature
Topics vary from year to year. Examples: the Puritan heritage; ethnic literatures in America; landscape in American literature; five American lives; pragmatism; American humor; transcendentalism; women regionalists. 4 cr.

851. Medieval Epic and Romance
The two major types of medieval narrative; comparative study of works from England, France, Germany, and Iceland, including *Beowulf, Song of Roland, Niebelungenlied,* Gottfried's *Tristan,* Njal's *Saga,* and Malory's *Morte d'Arthur.* All works read in modern English translations. 4 cr. (Not offered every year.)

852. History of the English Language
Evolution of English from the Anglo-Saxon period to the present day. Relations between linguistic change and literary style. 4 cr. (Not offered every year.)

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

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

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

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

859. Milton
Milton and his age. Generous selection of Milton's prose and poetry, with secondary readings of his sources and the scholarship. 4 cr. (Not offered every year.)

863. Continental Backgrounds of the English Renaissance
Major philosophers, artists, and writers of the continental Renaissance (in translation): Petrarch, Ficino, Pico, Vives, Valla, Castiglione, Machiavelli, Luther, Calvin, Rabelais, Montaigne, Cervantes, Erasmus, and Thomas More, as representative of the early English Renaissance. 4 cr. (Not offered every year.)

864. Prose and Poetry of the Elizabethans
Shakespeare and his contemporaries. Major works, including Spenser's *Faerie Queene,* Sidney's *Astrophil and Stella,* Shakespeare's *Sonnets,* Marlowe's *Dr. Faustus*: their literary and intellectual backgrounds. 4 cr. (Not offered every year.)

865. English Literature in the 17th Century
Major writers of the 17th century, including Donne, Jonson, Herbert, Bacon, and Hobbes. 4 cr. (Not offered every year.)

867, 868. Literature of the Restoration and 18th Century
Representative works; texts studied closely; the ways they reflect the central intellectual problems of their age. 867: Milton, Dryden, Rochester, Restoration plays, Defoe, Swift, and Pope. 868: Fielding, Johnson, Boswell, Voltaire, Sterne, Rousseau, Beckford, Diderot, Godwin, and Blake. 4 cr.

869, 870. The English Romantic Period
Major literary trends and authors, 1798 to 1832. Focus on poetry but attention also to prose works and critical theories. 769/869: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770/870: Byron, Shelley, Keats. 4 cr. (Not offered every year.)

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

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

875. Irish Literature
Survey from the beginnings to the present; works in Irish (read in translation) such as The Cattle Raid of Cooley, medieval lyrics, and Mad Sweeney; and works in English from Swift to the present. Twentieth-century authors: Joyce, Yeats, Synge, O'Casey, Beckett, and Flann O'Brien. 4 cr. (Not offered every year.)

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

879. Linguistic Field Methods
Devoted to the study, with use of an informant, of some non-Indo-European language that is unfamiliar to both the students and the instructor at the beginning of the class. The primary aim of the course is to give students a practical introduction to linguistic analysis without the support of a text. Theoretical concepts are introduced as needed. 4 cr.

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

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

882. Modern Drama
Major English, American, and (translated) European plays of the modern period by such playwrights as Shaw, Ibsen, Chekhov, Strindberg, Pirandello, O'Neill, Brecht, Beckett, Williams, Miller, Pinter. Live and filmed performances studied as available. 4 cr. (Not offered every year.)

883. The English Novel of the 18th Century
The rise and development of the novel through study of selected major works by Defoe, Richardson, Fielding, Smollett, Sterne, and Austen. 4 cr.

884. The English Novel of the 19th Century
Representative novels from among Austen, Scott, Dickens, Thackeray, Emily Brontë, Charlotte Brontë, Trollope, George Eliot, Hardy, and Conrad. 4 cr.

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

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 Theory
An advanced course on a topic to be chosen by the instructor. Inquire at the English department office for a full course description each time the course is offered. Topics such as word formation, dialectology, linguistic theory and language acquisition, language and culture, cross-disciplinary studies relating to linguistics. Barring duplication of subject, may be repeated for credit. 4 cr.

891. English Grammar
A survey of the grammar of English (pronunciation, vocabulary, sentence structure, punctuation, dialect variation, historical change) with special attention to the distinction between descriptive and prescriptive grammar and to the problems students have with formal expository writing. 4 cr.

892. Teaching Secondary School English
Methods of teaching language, composition, and literature in grades 7-12. Required of all students in the English teaching major. Open to others with permission. 4 cr.

893. Phonetics and Phonology
The sounds and sound systems of English in the context of linguistic theory: comparisons of English to other languages. Prereq: a basic linguistic course or permission. 4 cr. (Not offered every year.)

894. Syntax and Semantic Theory
The relationship of grammar and meaning as viewed from the standpoint of modern linguistic theory. Emphasis on the syntax and semantics of English, with special attention to the construction of arguments for or against particular analyses. Prereq: a basic linguistic course or permission. 4 cr.

897. Special Studies in Literature
A) Old English Literature; B) Medieval Literature; C) 16th Century; D) 17th Century; E) 18th Century; F) English Romantic Period; G) Victorian Period; H) 20th Century; I) Drama; J) Novel; K) Poetry; L) Nonfiction; M) American Literature; N) A Literary Problem; O) Literature of the Renaissance. The precise topics and methods of each section will vary. Barring duplication of subject, may be repeated for credit. For details, see the course descriptions available in the English department. 2–6 cr.

901. Advanced Writing of Fiction
Workshop discussion of advanced writing problems and readings of students' fiction. Individual conferences with instructor. Prereq: writing fiction or equivalent. Written permission of instructor required for registration. May be repeated for credit with the approval of the department chairperson. 4 cr.

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

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

920. Issues in Teaching English and the Language Arts
Special topics in the teaching of English and the language arts. Inquire at the department to see what topics in the teaching of reading, writing, literature, or language arts may be scheduled. Open only to graduate students with a professional interest in teaching or to practicing teachers. 1–6 credits depending on the specific course.

924. Bibliography and Methods
Introduction to enumerative and physical bibliography and major research and reference works of the field, to prepare the student for original research in the graduate program and later. Required of all Ph.D. students. 2 cr. Cr/F.

925. The Graduate Study of Literature
Techniques, resources, and purposes of literary study: close reading; practical criticism; critical theories and their values; pertinence of intellectual and historical backgrounds. Approaches applied to a specific area of literary study, which varies from year to year. 4 cr.

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

Seminars

914. Seminar—Rhetorical and Composition Theory
4 cr.

917. Seminar—Teaching Writing
4 cr.

926. Seminar—Literary Theory
4 cr.

927. Seminar—Feminist Criticism Theory and Practice
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—Twentieth-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
Professor: James S. Bowman
Associate Professors: John F. Burger; Donald S. Chandler; G. Thomas Fisher; Paul C. Johnson; R. Marcel Reeves
Adjunct Assistant Professor: Siegfried E. Thewke
Graduate Program Coordinator: 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 lacking the necessary background courses may be required to complete certain of these courses without credit before they are admitted to full candidacy for a degree. Applicants are required to submit general and subject biology scores from the Graduate Record Examination.

M.S. Degree Requirements

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

804. Medical Entomology
Survey of past and present trends in arthropod-borne diseases transmitted to human populations, emphasizing dynamics of arthropod-host-pathogen/parasite relationships, natural nidality of disease, and role of arthropods and other animals as reservoirs or vectors of disease and maintenance of zoonoses. Laboratory emphasizes survey of arthropod groups important as disease vectors or in envenomizing humans. Lab. 4 cr.

805. Systematics and Taxonomy of Insects
The kinds and diversity of insects and their relationships, emphasizing methods of species and population analysis, concepts of classification and nomenclature, and application to identification. Prereq: intro. ento.;/or permission. Lab. 4 cr.

806. Terrestrial Arthropods
Biology, ecology, and systematics of the principal terrestrial arthropods, with emphasis on forest and grassland communities. The role of arthropods in decomposition and nutrient cycling, and the effects of forestry and agricultural practices on the fauna are considered—collection, extraction, identification, and experimental procedures. Prereq: permission. (Also offered as 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, 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, culture, and chemical control with principles of insect ecology into management approach for insect pests. Prereq: permission. 4 cr.

901. Graduate Entomology
Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Subject matter, hours, and credits to be arranged. 1–4 cr.

997, 998. Entomology Seminar
Selected topics and current developments. Required of all graduate entomology students. May be repeated. 1 cr.

899. Master's Thesis
Hours and credits to be arranged. 6–10 cr.

Family and Consumer Studies (FS)

Chairperson: Larry J. Hansen
Associate Professors: Kristine M. Baber; Elizabeth M. Dolan; Larry J. Hansen; Michael F. Kalinowski; Victor R. Messier
Assistant Professors: Walter L. Ellis; Barbara R. Frankel; Li-ying Hilary Wang
Graduate Program Coordinator: Elizabeth M. Dolan

Degree Offered

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

Admission Requirements

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

M.S. Degree Requirements

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

Marriage and Family Therapy Option
This option specifically prepares students

to work in mental health, family service, medical, and human service settings. The emphasis is on structural, strategic, and systemic approaches to marriage and family therapy. Program requirements for the master of science degree for students admitted to the marriage and family therapy option include (1) the 12-credit core curriculum; (2) 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 Problems in Family Life; 947, Family Therapy Practice II; and (3) successful completion of at least 10 credits of 898 (500 hours of clinical practice) and an integrative paper. Clinical training is provided under the direction of an approved supervisor of the American Association for Marriage and Family Therapy in the department's Marriage and Family Therapy Clinic.

807. Practicum
Supervised in-depth experience in teaching, research, or advocacy in a professional setting to increase the student's understanding of children, families, or consumer issues. A) Child; B) Family; C) Consumer Studies. Prereq: permission. 1–6 cr. Cr/F.

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

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

833. Supervising Programs for Young Children
Philosophical bases and theoretical rationales of various programs for young children; program alternatives and resources; issues in administration including supervision, finances, and regulations. Prereq: permission. 4 cr. (Fall semester only.)

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

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

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

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

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

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

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

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

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

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

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

943. American Families in Poverty
Seminar in contemporary issues related to economic deprivation in families. Exploration of causes and effects of poverty in American families. Prereq: permission. 4 cr. (Not offered every year.)

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

945. Family Therapy Practice I
Designed to develop 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 (i.e., 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 a part of the experience. These seminars are open to graduate students with sufficient background and are not scheduled every semester. One or more semesters, maximum of 4 credits in one area. Prereq: permission. 2–4 cr.

997. Advanced Research Seminar
Interdisciplinary approach to research in child, family, and consumer studies. Emphasis on the multidimensionality of family problems, appropriate research strategies, and critical analysis of current literature. Prereq: permission. 4 cr.

899. Master's Thesis
6 cr.

Forestry (FOR)

(See Department of Natural Resources)

Genetics Program (GEN)

Chairperson: Anita S. Klein
Professors: Donald M. Green; Yun-Tzu Kiang; J. Brent Loy; Subhash C. Minocha; Lincoln C. Peirce; Owen M. Rogers; Willard E. Urban, Jr.; Robert M. Zsigray
Associate Professors: Thomas M. Davis; Clyde L. Denis; Robert T. Eckert; Anita S. Klein; Robert L. Taylor, Jr.
Assistant Professors: John J. Collins; Thomas D. Kocher
Adjunct Assistant Professor: Peter W. Garrett
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 3 genetics courses for a minimum of 10 credits (seminars and thesis excluded). Candidates for the degree will be required to complete a thesis and pass an oral examination covering graduate courses and thesis.

Ph.D. Degree Requirements

The chairperson of the genetics program, with the concurrence of the chairperson of the department of major interest, nominates the student's guidance and doctoral committees, which administer the qualifying and final examinations. Specific course requirements are developed by the student and the guidance committee. Doctoral students are expected to have a broad exposure to genetics courses, exceeding that required of master's students. Students must complete a dissertation on original research in genetics.

The guidance committee for each graduate student determines whether a foreign language will be required.

Teaching Experience

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

804. Microbial Genetics
Expression and transfer of genetic elements (chromosomal and nonchromosomal) in prokaryotic and eukaryotic microorganisms; consideration of factors influencing public health, industry, the environment, and society. Prereq: gen. micro.; physiol. chem. and nutrition. (Also offered as MICR 804.) Lab. 4 cr.

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

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

840. Evolutionary Biology
Origin of source of genetic variation, population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and humans; community structure and evolution. Prereq: prin. of genetics or permission. (Also offered as PBIO 840.) 4 cr. (Not offered every year.)

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

872. Introductory Laboratory in Molecular Genetics Techniques
Modern biochemical gene manipulation techniques, including the genetic, physical, and enzymatic characterization of gene vectors, gene cloning, construction of genetic probes, and sequencing of nucleic acids. Prereq: BCHM 852; BCHM 871 or MICR 804. (Also offered as BCHM 872.) Special fee. 3 cr.

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

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

902. Design of Experiments
Practical application of common experimental designs to research problems: the use of design to compensate for interfering factors, treatment, selection (particularly when several factors are suspected of having an influence on response), and computer-aided analysis of results. Prereq: statistics. 3 cr. (Not offered every year.)

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

912. Advanced Statistical Methods
Methods and techniques for handling typical problems that arise in the analysis of data. Topics include the multiple comparison of means, analysis of unweighted means, proportional subclass numbers, weighted squares of means, orthogonal polynomials, and least squares. Prereq: FOR 811; digital computer systems;/or permission. 3 cr. (Not offered every year.)

942. Biochemical Regulatory Mechanisms
Nonreplicative functions of DNA; transcription and translational control of protein synthesis; quantitative regulation of proteins; regulation of metabolism by hormones, allosteric regulation and repression; regulatory mechanisms operating during development and differentiation. Prereq: BCHM 852 or permission. (Also offered as BCHM 942.) 3 cr.

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

995, 996. Special Topics in Genetics
Intended for study in specialty areas not ordinarily included in other courses. May involve formal classes, discussions, or independent investigations. Prereq: permission. 2–4 cr.

998. Genetics Seminar
Presentation and discussion of selected genetic topics. 1 cr. Cr/F. (May be repeated.)

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Courses Available in Related Areas

These courses are fully described below and under the appropriate department for the convenience of the student.

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

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 characters, quantitative data analysis. Prereq: prin. of genetics; silviculture; or permission. Special fee. Lab. 3 cr. (Not offered every year.)

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

873. Breeding Improved Varieties
Techniques for creating new varieties of crop and ornamental plants. 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, Lee F. Seidel
Associate Professors: Robin D. Gorsky, Marc D. Hiller, Jeffrey Colman Salloway, John W. Seavey
Assistant Professors: James B. Lewis, Eileen A. O'Neil

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 the each of the following areas: financial accounting, finite math or calculus, microeconomics; (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.

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 required and four elective courses normally completed over twenty-two months of study involving two weekends per month (Friday/Saturday) from September through late May, plus two residential periods of six days (five nights) each—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.

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.

902. Social Science and Health Care
Examines how social science is applied to the field of health care management and policy; emphasis on the contributions of sociology, psychology, and political science. 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. 1–3 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. 1–3 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. Research, Data Management, and Analysis
Discusses the scientific method, problem identification, data collection, methodology, data management, data analysis, and the use of statistics. Emphasis on health care management and policy. 3 cr.

912. Quantitative Methods in Health Care Management
Applications of statistical methods, operations research, and quantitative management sci-

ences 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.

922. Advanced Organizational Methods in Health Care
The use of interorganizational theory in the design, management, and evaluation of integrated personal health care systems. Examines corporate models; covers ambulatory, mental health, hospital care, and long-term care services. 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. 1–3 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. 1–3 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. 1–3 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. 1–3 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 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. 1–3 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; David F. Long; 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; Janet L. Polasky; Marc L. Schwarz
Assistant Professors: Cathy Ann Frierson; Jan V. Golinski; Gregory McMahon; Lucy 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 in 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 at the undergraduate level in history, 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 on the Graduate Record Examination. The department assesses the student's entire application, including letters of recommendation, in making its decision on admission. Deficiencies in an undergraduate program may be rectified by coursework as a special student, but such coursework cannot be used to satisfy requirements for an advanced degree. The department also recommends that a beginning graduate student have some training in a foreign language. Students in seminar or reading courses in other than American history 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) courses in the entirety of U.S. history, with accent upon either early or modern U.S. and two subfields outside of American history;
6) 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.

Apprenticeship

The department considers that graduate work in history, and particularly doctoral work, is professional training. All entering graduate students intending a Ph.D. are, consequently, required (and all others are urged) to participate on a continuing basis in HIST 801, Proseminar: History as a Profession. Moreover, the department recognizes the dual concerns of the historian's life—teaching and research; when feasible, therefore, all doctoral students are expected to undertake teaching in the department during a part of their residence. Participation in proseminar and in teaching constitutes an apprenticeship in conjunction with formal study.

All graduate students are reviewed annually by the faculty of the department. A student accumulating two course failures is automatically barred from continuing in any degree program in history, but the department reserves the right to exclude others whose overall performance does not give reasonable assurance of a successful program completion. Students are allowed no more than three attempts to meet any language requirements.

801. Proseminar: History as a Profession
Entering graduate students intending the doctorate and all advanced graduate students serving as research, program, or teaching assistants in the department meet periodically to discuss the obligations and mechanics of the historian's profession, including teaching, scholarship, university and college structures, and the role of the faculty therein. 0 cr.

803. The European Conquest of North America
A study of the social consequences of colonization, migration, and war in America, 1500–1775. Emphasis on the interaction of British colonists with competing European cultures (French, Dutch, Portuguese, and Spanish), with native Americans, and with African and Afro-American slaves. 4 cr.

805, 806. America in the 18th Century and the Revolution
Advanced study in American colonial and revolutionary history from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. 4 cr.

807. The American Character: Religion in American Life and Thought
Interdisciplinary study of the American religious experience and its relationship to other aspects of American culture. Taught by a team of three specialists, each in a different discipline: American intellectual and cultural history, American literature, and American church history. Central emphasis is given to several transforming themes of the nineteenth century and their effects upon the interplay of religion and society. 4 cr.

808. Arts and American Society: Women Writers and Artists, 1850–Present
Team-taught course studying the impact of gender definitions on the lives and works of selected American artists. Considers lesser-known figures such as Fannie Fern, Lilly Martin Spencer, and Mary Hallock Foote as well as better-known artists such as Willa Cather and Georgia O'Keeffe. 4 cr.

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.

810. American Studies: New England Culture and Changing Times
Advanced study in New England culture. A team of three instructors from history, literature, and art investigate major contributions New England has made to American life. Focus on the Puritan era, 1620–90; the transcendental period, 1830–60; and the period of emerging industrialism in the late 19th century. 4 cr.

811. 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
Advanced study in the history of American thought. Significant American thinkers considered in their social context. Semester I: 1600–1860. Semester II: 1860–present. 4 cr.

823. Anglo-American Social History
Study of everyday life in British America and the early United States, 1600–1820, with an emphasis on gender, class, and race. Consideration of childbearing, labor systems, religious

observance, crime, and other themes in the light of recent social theory. Readings in both primary and secondary literature, with an emphasis on local records and on material culture. 4 cr.

824. Modern 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. European Intellectual History
Advanced study in the European intellectual tradition from the Greek philosophers to the end of World War II. How basic ideas have developed out of previous modes of thought in response to new challenges. 4 cr.

856. 20th-Century Europe
Advanced study of 20th-century Europe. World War I, European totalitarianism, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

859. History of Spain and Portugal
Advanced study of Iberian states and their peoples from the coming of liberalism to the present. Failure of Iberian and liberal government. Political and social change, imperial and intellectual movements, influence of Western European thought and activity. 4 cr.

861, 862. England in the Tudor and Stuart Periods
Advanced study of England during the Tudor and Stuart periods. Political, religious, socioeconomic, and intellectual forces for change at work in England from the accession of Henry VII to the revolution of 1688–89. 4 cr.

863. Russia: Origins to Modernization
Advanced study of Russia from its foundation to emancipation and reform. Political developments, foreign relations, intellectual and ideological currents. 4 cr.

864. Russia: From Tsarist to Soviet Empire
Advanced study of modern Russia. The cost of modernization; Leninist and Stalinist revolutions; Soviet consolidation. 4 cr.

865. Themes in Women's History
In-depth examination of a selected topic in women's history, such as women and health, women in modern European political theory, comparative history of women and revolution. See *Time and Room Schedule* or department for specific topic. May be repeated for credit with permission of instructor. 4 cr.

867. Early Modern Germany: Reformation to the Revolution of 1848
Advanced study of early modern Germany. Conflict between Holy Roman Empire and petty states; rise of Prussia; religious conflict and Enlightenment. 4 cr.

868. Modern Germany since 1848
Advanced study of early modern Germany. Bismarck and Imperial Germany; Weimar and the rise of Hitler; post-World War II divided Germany. 4 cr.

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

874. Historiography
Analysis of ancient and modern historians. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

875. Historical Methods
Introduction to contemporary historical methods. Required of all entering Ph.D. candidates; open to undergraduates with permission. 4 cr. (Not offered every year.)

877. The Roman World
Covers Rome's rise as a republic, the foundation of the Empire, and the later Empire through Constantine's reign. Discusses Roman art, literature, and philosophy as well as religious developments such as the proliferation of mystery religions and the rise of Christianity. Weekly seminar for discussion of readings by Roman authors. 4 cr.

881. Topics in the History of Modern China
Advanced study of issues in modern Chinese history, 1800 to present. 4 cr.

883. Religion in World History
Advanced study in the religious experience of man from the perspective of world history. The major modes of religion; development of the major religious traditions and institutions. 4 cr.

884. History of Southern Africa since 1820
Advanced study of southern Africa. Struggle for political and economic control in the only region of Africa where European groups remain in power. Effect of European imperialism, European settler nationalism, racial conflict, economic competition and industrialization, apartheid, and assimilation with special attention to development of European hegemony. Official American policy. 4 cr.

885. The Modern Middle East
Advanced study of the Middle East from 18th century to the present. Problems created by modernization and reform of the traditional society; conservative reaction to reform, impact of nationalism, and appearance of new ideologies. 4 cr.

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

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

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

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

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

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

995, 996. Tutorial Reading and Research in History
A) Early American History; B) American National History; C) Canada; D) Latin America; E) Medieval History; F) Early Modern Europe; G) Modern European History; H) Ancient History; I) Far East and India; J) Near East and Africa; K) European Historiography; L) American Historiography; M) Russia; N) World History; O) English History; P) New Hampshire History; Q) Historical Methodology; R) Irish History. Prereq: permission. 1–6 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research

Hydrology

(See Earth Sciences.)

Master's Continuing Enrollment (MCE)

900. Master's Continuing Enrollment
Master's students who have completed all course requirements and have previously registered for the maximum number of thesis or project credits and are on campus completing their master's program must register for Master's Continuing Enrollment. MCE 900 is an enrollment designation that appears on the academic record. Students registered for MCE 900 are considered full time; no credit hours are accumulated nor a grade given.

Mathematics (MATH)

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

Degrees Offered

The Department of Mathematics offers programs leading to a master of science in teaching degree in mathematics, a master of science degree in mathematics, a doctor of philosophy degree in mathematics, and a doctor of philosophy degree in mathematics education.

In general, the master's degree programs offer the student a high level of professional training for employment as well as appropriate preparation for programs leading to the Ph.D. degree. The Ph.D. programs are designed primarily for a career in post-secondary school teaching and research.

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

Admission Requirements

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

M.S. Degree Requirements

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

Master of Science for Teachers Degree Requirements

The program requires ten semester courses approved by the department. These will normally be taken from the courses numbered 901–929 and will usually include the six courses numbered 903–908. A comprehensive examination based primarily on material in courses 903–908 is required. The courses in this program are offered primarily during summer sessions.

Ph.D. Degree Requirements

Basic degree requirements for the Ph.D. program: (1) all of the courses numbered 933–939; (2) experience in teaching equivalent to at least half time for one year; and (3) written comprehensive examination in algebra, analysis, and topology.

Additional degree requirements for the Ph.D. in mathematics: (4) proficiency in reading mathematical literature in two of 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.

Additional degree requirements for the Ph.D. in mathematics education: (4) language requirement as in Ph.D. in mathematics except that mastery of an approved research tool may be substituted for one language; (5) advanced work in a major (mathematics-education) and a minor (usually education) with an oral examination in these two fields; and (6) a thesis that includes original results in mathematics education.

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

835. Probability
Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson, and normal distributions; limit theorems for sums of random variables. Prereq: multidim. calculus. 4 cr.

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

839. Linear Statistical Models
Estimation, testing, and diagnostic methods for linear regression, analysis of variance, and analysis of covariance. Some experience in the use of packaged statistical computer programs. Prereq: MATH 836 and 862. 4 cr.

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

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

845-846. Foundations of Applied Mathematics
Basic concepts and techniques of applied mathematics intended for graduate students of mathematics, engineering, and the sciences. Fourier series and transforms, Laplace transforms, optimization, linear spaces, eigenvalues, Sturm-Liouville systems, numerical methods, conformal mapping, residue theory. 4 cr.

853. Numerical Methods and Computers I
Use of scientific subroutine and plotter-routine packages, floating point arithmetic, polynomial and cubic spline interpolation, implementation problems for linear and nonlinear equations, random numbers and Monte Carlo method, Romberg's method, optimization techniques. Selected algorithms will be programmed for computer solution. Prereq: calculus II; intro. to data structures with C or scientific programming with FORTRAN or intro. to computer science II. (Also offered as CS 853.) 4 cr.

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

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

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

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

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

868. Advanced Analysis
Metric spaces; sequences and series of real functions; uniform convergence; Fourier series; differentiability of mappings from n-space to m-space. Prereq: MATH 867. 4 cr. (Not offered every year.)

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

883. Set Theory
Axiomatic set theory, including its history, Zermelo-Fraenkel axioms, ordinal and cardinal numbers, consistency, independence, and undecidability. 4 cr. (Not offered every year.)

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

888. Complex Analysis
Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Prereq: MATH 867. 4 cr.

The following courses may be applied to the degree of master of science for teachers in mathematics and to no other degree in mathematics.

901-902. Mathematics and Computing for Teachers
An introductory course designed to familiarize the students with the capabilities of a computer and to enable them to use it confidently. Applications to algebra, analysis, logic, and game theory are examined; includes introduction to microcomputers. 3 cr.

903-904. Higher Algebra for Teachers
The integers, integral domains, and topics from number theory; equivalence relations and congruences; real numbers, complex numbers, fields, and polynomials; group theory; matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

905-906. Higher Geometry for Teachers
Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. 3 cr.

907-908. Higher Analysis for Teachers
The real number system; functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. 3 cr.

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

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

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

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

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

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

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

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

921. A Modern Approach to Geometry
The foundations and development of Euclidean geometry, with emphasis on the recent recommendations in the field of high school geometry. 3 cr.

926. Selected Topics in Algebra
Topics selected to supplement the teacher's previous training in algebra, chosen from among the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 cr.

927. Selected Topics in Geometry
Topics selected to supplement the teacher's previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 cr.

928. Selected Topics in Analysis
Topics selected to supplement the teacher's previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 cr.

929. Directed Reading
A directed reading project on a selected topic in mathematics, planned in collaboration with a faculty member. 3 cr.

The following are the basic courses for both the master of science and doctor of philosophy degrees in mathematics.

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

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

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

936. Functional Analysis
Banach and Hilbert spaces, Hahn-Banach theorem, open mapping and closed graph theo-

rems, 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: Robert W. Corell; David E. Limbert; Godfrey H. Savage; Charles K. Taft
Associate Professors: Kenneth C. Baldwin; Barbaros Celikkol; Todd Stuart Gross; Robert Jerard; James E. Krzanowski; William Mosberg; M. Robinson Swift; John A. Wilson
Assistant Professors: Barry K. Fussell; John Philip McHugh; James A. Sherwood; David W. Watt
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, postulational approach and Legendre transformations to obtain thermodynamic potentials. 4 cr.

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

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

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

809. Computational Fluid Dynamics
Solution of basic finite-difference methods for incompressible and compressible flows with practical examples. Treatment of boundary/initial conditions; analysis of stability and convergence of the numerical schemes. Prereq: fluid dynamics; heat transfer or permission. 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
Stress, strain, stress-strain relations, anisotropic behavior, introduction to elasticity, plane stress/strain, bending and torsion of members with general cross-sections introduction to thin plates and shells, energy methods. 4 cr.

830. Mechanical Behavior of Materials
Elastic and inelastic behavior of materials in terms of micro- and macromechanics. Stress, strain, and constitutive relations related to recent developments in dislocation theory and other phenomena on the atomic scale and to the continuum mechanics on the macroscopic scale. Elasticity, plasticity, viscoelasticity, creep, fracture, and damping. Anisotropic and heterogeneous materials. 4 cr.

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, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects selected and completed by student teams. Prereq: permission. (Also offered as OE 852.) 4 cr.

857. Coastal Engineering and Processes
Introduction to small amplitude and finite amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline protection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as CIE 857; OE 857.) 3 cr.

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

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

866. Physical Ceramics
Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation and crystal growth, spinodal decomposition, and solid-state reactions; kinetics of grain growth; sintering, and vitrification. Prereq: permission. 4 cr.

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

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

874. Computer-Aided Engineering
Data acquisition and experiment control, multivariable data curve fitting, computer simulation of lumped systems based on analytical and databased models, graphical display of data and simulation results. Interactive graphics and 3-D line drawing of objects for finite element analysis. Introduction to finite element analysis and survey of other software available. Prereq: ME 849 or permission. 3 cr.

881. Mathematical Methods in Engineering Science I
Solution of discrete and continuous systems. Review of calculus, linear algebra, complex numbers, Fourier series, differential and partial differential equations with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 cr.

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. (Also offered as CIE 886 in alternate years). 3 cr.

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

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

903. Conduction Heat Transfer
Heat conduction equation temperature fields and heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 4 cr.

904. Radiation Heat Transfer
The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories.

Methods of solution of radiant interchange in real systems with and without absorbing media. 4 cr.

906. Convection Heat Transfer
An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 cr.

907. Compressible Fluid Flow
General equations of motion for real and ideal compressible fluid flow including normal and oblique shocks, Prandtl Meyer flow, and methods of solutions. Applications to jet propulsion and turbo machinery. Prereq: ME 807 or 808. 4 cr.

908. Theoretical Aero/Hydro-Mechanics
The mathematical development of the equations of frictionless fluid flow, using both tensor notation and various coordinate systems. Conformal mapping; Blasius theorem; Joukowski hypothesis; flow around airfoils. Schwarz Christoffel theorem and vortex motion. 4 cr.

909. Viscous Flow
Exact solutions of the Navier-Stokes equations; laminar boundary layers; wakes and jets; Stoke's 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 hydromagnetic influences; instability of parallel viscous flows including the Orr-Sommerfeld equation and Tollmein-Schlicting waves; instability of free-surface waves; instability of stratified flows; instabilities in porous media. Prereq: ME 807 or permission. 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; and nonlinear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases; and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

924. Vibrations of Continuous Media
Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

926. Theory of Elasticity
The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogeneous, anisotropic, wave equations; wave propagation and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques are used. 4 cr.

927. Theory of Plasticity
Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

929. Theory of Plates and Shells
Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.

938. Theoretical Acoustics
Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

942. Discontinuous Control
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods that use the quantized nature of the information are also developed. Design methods for pulse-width modulation, optimum quantizers and limit cycle behavior of quantized systems are developed. (Also offered as EE 942.) 4 cr.

944. Nonlinear Control Systems
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: EE or ME 951. (Also offered as EE 944.) 4 cr.

951. Advanced Control Systems I
State-space representation of multivariable systems; analysis using state transition matrix. Controllability and observability; pole placement using state and output feedback; Luenberger observers. Introduction to computer-controlled systems (sampling, discrete state representation, hybrid systems): nonlinear analysis (Liapunov, Popov, describing function). Prereq: EE or ME 882. (Also offered as EE 951.) 3 cr.

952. Advanced Control Systems II
Special topics in control theory: continuous and discrete systems: optimal control systems, including calculus of variations, maximum principle, dynamic programming, Weiner and Kalman filtering techniques, stochastic 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 estimators, Weiner and Kalman filters, combined estimation and control, prediction, parameter identification, and nonlinear filtering. Prereq: ME or EE 951; MATH 835 or equivalent. (Also offered as EE 955.) 3 cr.

961. Physical Metallurgy II
Thermodynamics of solid solutions and mixtures, kinetics of selected solid state reactions including precipitation and recrystallization, martensite transformations. 4 cr.

965. Microscopic Mechanisms of Plastic Deformation
The mechanisms of plastic deformation in crystalline materials. Review of elasticity theory; point, line, and planar defects; dislocation interactions; strengthening mechanisms; creep mechanisms; application of deformation mechanisms to the development of constitutive models. Prereq: permission. 3 cr.

982. Mathematical Methods in Engineering Science II
Continuation of ME 881. Complex variable techniques, integral transform techniques for the solution of differential and partial differential equations, Green's functions. Weiner-Hopf techniques, variational techniques, stochastic problems with application to random vibration, statistical control theory, turbulence, heat conduction and fluctuation phenomena in solids, transport theory, gases, and liquids. Topics may vary from year to year. Prereq: ME 881. 4 cr.

992. Mechanical Engineering Master's Project
The student works with a faculty member during one or two semesters on a well-defined research and/or original design problem. A written report and seminar are presented. 4 cr.

995. Graduate Special Topics
Investigation of graduate-level problems or topics in mechanical engineering. 2–4 cr.

899. Master's Thesis
8 cr.

999. Doctoral Research

Microbiology (MICR)

Chairperson: Thomas G. Pistole
Professors: Richard P. Blakemore; William R. Chesbro; Thomas G. Pistole; Robert M. Zsigray
Associate Professor: Frank G. Rodgers
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, comparative immunology, molecular mechanisms of pathogenesis, environmental and molecular virology, microbial growth and regulation, marine microbial ecology, and biotechnology.

Admission Requirements

Applicants are expected to have had adequate preparation in the biological and physical sciences. This typically includes general and organic chemistry, physics, one semester of calculus, a year of general biology, a semester or more of biochemistry, and general microbiology. Formal courses in quantitative analysis and statistics are recommended. Applicants with deficiencies in these background courses who are admitted to the program may be required to complete appropriate coursework without graduate credit. Submission of Graduate Record Examination scores on the general test is required. Each applicant to the graduate program must be sponsored by a faculty member in the department. The sponsor's decision is usually based on the "Statement of Interest" section of the Application to Graduate School form. Persons planning to apply to the program should contact the graduate program coordinator in microbiology to obtain information on the department.

M.S. Degree Requirements

Students admitted to the M.S. program are required to conduct an independent research project in conjunction with a faculty adviser and must submit a thesis based on this research to a faculty examining committee, which determines its acceptability. Students also defend their completed thesis work in a formal departmental seminar. Specific coursework is determined in conjunction with the faculty adviser.

Ph.D. Degree Requirements

Students with appropriate academic training at the baccalaureate or master's level may be considered for admission to the doctoral program. Persons enrolled in the doctoral program are required to develop and execute an independent research project in conjunction with a faculty adviser, to complete and defend successfully a dissertation based on this research, to pass a written qualifying examination administered by the student's guidance committee, and to complete one semester of teaching.

The department's acceptance of the dissertation is contingent on (1) its approval by the doctoral committee and (2) evidence that at least one manuscript based on the thesis research has been submitted to a refereed scientific journal appropriate to the topic.

All graduate students are expected to enroll in MICR 997, Microbiology Seminar, each semester.

801. Taxonomy and Ecology
Isolation, identification, and classification of prokaryotic microorganisms by classical and newer techniques; analysis of the interplay between organisms and environment based on energy metabolism and use of this to deduce a natural classification; uses of taxonomic and ecological information. Prereq: gen. micro.; gen. biochem. Special fee. Lab. 4 cr.

802. Infectious Disease and Health
Principles underlying the nature of infectious agents and the diseases they cause. Pathogenic strategies employed by these microorganisms, response of the host at the animal and cellular levels, intracellular parasitism, epidemiology, role of control measures including vaccines and chemotherapy, mode of action of antimicrobial chemotherapeutic agents, pharmacokinetics and drug metabolism. Both well-established pathogens as well as newer and emerging human and animal disease agents will be covered. Prereq: pathogenic microbiology; permission. 4 cr.

804. Microbial Genetics
Expression and transfer of genetic elements (chromosomal and nonchromosomal) in prokaryotic and eukaryotic microorganisms; consideration of factors influencing public health, industry, the environment, and society. Prereq: gen. micro.; physiol. chem. and nutrition. (Also offered as GEN 804.) Lab. 4 cr.

805. Immunology
Examination of the immune response in vertebrates. Characterization of the major components of the immune system; study of host-defense mechanisms and immunopathology. Serological and animal laboratory studies. Prereq: gen. micro.; permission. Special fee. Lab. 5 cr.

806. Virology
Principles of animal and, in selected instances, plant and bacterial virology in relation to infection and disease. Emphasis on the molecular biology of viruses, viral replication, isolation, propagation, assay, pathogenesis, diagnosis, epidemiology, and control. Virus-host interactions. Prereq: gen. microbiol. or equivalent; permission. Special fee. Lab. 4 cr.

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

808. Microbial Biogeochemistry
Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferro-manganese nodules, corrosion, and fossil microorganisms. Prereq: gen. micro.; organic chem. Special fee. Lab. 4 cr.

810. Electron Microscopy and Microbial Cytology
Ultrastructure and function in eukaryotes, prokaryotes, and viruses. Practical operation of transmission and scanning electron microscopes, including manipulation of instrumentation and specimens. Application of shadowing, negative staining, embedding and thin sectioning, labeling, and freeze-fracture/etching to biological specimens; photographic techniques and the interpretation of micrographs. Discussion of role of bacterial appendages, cell membranes and cell walls, cytoplasmic inclusions, cell division and sporulation along with virus ultrastructure. Project work. Prereq: gen. microbiol.; permission. Special fee. Lab. 5 cr.

812. Microbial Symbioses
Biochemical, ultrastructural, and ecological aspects of stable host-microbe interactions; principally between prokaryotes and eukaryotes. Discussion focuses on several systems including animal digestive tracts and nutritive and luminous organs. Considerable attention is also given to plant-microbe interactions, especially those involving *Rhizobium* and *Agrobacterium*. Prereq: gen. micro.; gen. biochem.; permission. Special fee. Lab. 4 cr.

814. Water Pollution Microbiology
Application of general principles of microbial ecology, disease, genetics, and physiology and of organic and inorganic chemistry to water pollution and its abatement. Prereq: gen. micro. 3 cr.

816. Advanced Immunology
Basic concepts in immunology including immuno-recognition, effector systems, immunogenetics, immunopathology, and comparative immunology. Prereq: gen. immunology; gen. biochem.; permission. Lab. 4 cr. (Not offered every year.)

851. Cell Culture
Theory and principles fundamental to 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. (May be repeated.)

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Music (MUSI)

Chairperson: John E. Rogers
Professors: Keith Polk; Mary H. Rasmussen; John E. Rogers; David E. Seiler
Adjunct Professor: Clark Terry
Associate Professors: Ruth S. Edwards; Stanley D. Hettinger; Cleveland L. Howard; Christopher Kies; Nicholas N. Orovich; W. Niel Sir; Robert Stibler; Peggy A. Vagts; Larry J. Veal; Paul F. Verrette; Henry J. Wing, Jr.
Assistant Professors: Mark S. Deturk; Robert W. Eshbach; Kathleen Wilson Spillane; 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.

Admission Requirements

Master of Arts in Music A bachelor of arts degree in music or its equivalent from an accredited institution is required for admission to this program. A performance audition and a placement examination in music theory and music history are required of all applicants. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the satisfaction of the department. A reading knowledge of both German and French is strongly recommended before entering the program; a German reading examination will be administered by the department. On recommendation of the graduate adviser, this requirement may be waived for students who do not plan further study beyond the M.A. degree.

Master of Science in Music Education Admission to this program requires a bachelor's degree in music education or its equivalent from an accredited institution. A performance audition and a placement examination in music theory and music history are required of all applicants. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the department's satisfaction.

M.A. Degree Requirements

The degree of master of arts in music, while designed basically for students interested in broadening their knowledge of the history of music, has proven valuable to students who wish to augment undergraduate degrees in performance and/or music education with more intensive studies in music theory, music literature, and performance-practice. The following courses (or their approved equivalents) are required: MUSI 955, 956, 957, 958, 991, and 994. Courses at the 800 and 900 levels in music, or at the 700, 800, and 900 levels in other departments, may be elected, with the approval of the student's adviser, to augment the required courses for a minimum total of 30 credits. Students emphasizing performance-practice are encouraged to give a graduate recital. Completion of the program requires a written essay of substantive nature on a topic of the candidate's special interest and a comprehensive oral exam. The latter includes analysis and historical discussion of scores from all periods of music. It is recommended that more than two semesters be allowed for completion of the degree.

M.S. Degree Requirements

The goal of the master of science in music education degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, and theory. The following courses are required: MUED 983 or 984; MUED 995 and 996; and MUSI 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
A) J. S. Bach; B) Franz Schubert; C) Debussy and Ravel; D) The World of Jazz; E) The Iconography of Western European Musical Instruments; F) 19th-Century French Music; G) Advanced Analysis; H) Advanced Study in Electronic Music; I) Composition through Computer-generated Sound; J) Woodwind Literature; K) Brass Literature; L) String Literature; M) Medieval Performance Practice; N) Renaissance Performance Practice; O) Baroque Performance Practice; P) Classical Performance Practice; Q) 19th-Century Performance Practice; R) 20th-Century Performance Practice; S) Woodwind Repair; T) String Repair; U) Advanced Jazz Improvisation; V) Advanced Piano Pedagogy; W) Advanced Accompanying; X) Advanced Conducting; Y) Independent Study. Prereq: permission. May be repeated for credit with permission. 1–4 cr.

955. Introduction to Bibliography
An intensive survey of basic reference works, music periodicals, collected editions, series, treatises, books on musical instruments and performance practice, and the important monographs on major composers from Machaut to Schoenberg. A reading knowledge of German and French is very useful. 3 cr.

956. Readings in Music History: Antiquity to 1600
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

957. Readings in Music History: 1600–1820
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

958. Readings in Music History: 1820 to the Present
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

991. Research Seminar
Guidance in individual research projects. Prereq: permission. 1–4 cr.

995. Independent Study in the History and Theory of Music
Opportunity for especially qualified students to investigate, with guidance, specific areas of their scholarly concern. Prereq: permission. 1–4 cr.

Theory and Composition

871-872. Counterpoint
Contrapuntal techniques of tonal music. Melodic construction and dissonance treatment through work in species counterpoint and studies in harmonic elaboration and prolongation. Analysis of selected compositions emphasizes the connection between fundamental contrapuntal techniques and the voice-leading of composition. Prereq: music theory II or permission. 2 cr.

875-876. Composition
Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prereq: music theory II or permission. 3 cr.

877. Advanced Composition
Continuation of MUSI 876. Individual compositional projects. Prereq: MUSI 876 and permission. May be repeated for credit. 3 cr.

879. Orchestration
Characteristics of band and orchestral instruments both individually and in small (homogeneous) and large (mixed) groupings. Students study scores, write arrangements, and have arrangements performed if at all possible. Some aspects of vocal writing. Prereq: music theory II or permission. 3 cr.

881, 882. Analysis: Form and Structure
An introduction to analytical techniques through the study of representative masterworks; formal and structural elements and their interrelationships. Semester I: analysis of 18th- and 19th-century works; semester II: analysis of 20th-century works. Prereq: music theory II or permission. 2 cr.

885. Electronic Sound Synthesis
Analog and digital synthesizers, methods of sound synthesis (e.g., fm synthesis), MIDI programming in BASIC, control programs for synthesizers (e.g., Personal Composer). 4 cr. (Generally offered Spring.)

895. Special Studies in Music
Refer to History and Literature section.

994. Theory Seminar
Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. Prereq: permission. 3 cr.

995. Independent Study in the History and Theory of Music
Refer to History and Literature section.

Performance

841-851. Applied Music for Graduate Credit
The following courses offer further development of technique, music interpretation, and repertory on the various instruments. Emphasis may also be directed toward the functional use of the instrument in the school room. Private lessons are based on a half-hour of individual instruction per week. One semester-hour credit may be earned with one lesson per week; 2 or 4 semester hours of credit may be earned with two lessons per week. Five one-hour practice periods are expected for each credit of private study. The special fee for a one-half hour lesson per week is $35 per semester in addition to normal tuition charges. The fee includes the use of a practice room for the required preparation. Prereq: student must exhibit sufficient proficiency to warrant graduate study and must have permission of the department chairperson and the student's graduate adviser. Audition required. A student may register for credit in the same courses in successive semesters with the approval of the major adviser. 1, 2, or 4 cr.

841. Graduate Voice

842. Graduate Piano

843. Graduate Harpsichord

844. Graduate Organ

845. Graduate Violin, Viola

846. Graduate Violoncello, String Bass

847. Graduate Woodwind

848. Graduate Bass

849. Graduate Percussion

850. Graduate Harp

851. Graduate Early Wind Instruments

895. Special Studies in Music
Refer to History and Literature section.

Music Education (MUED)

841-842. Techniques and Methods in Choral Music
Problems in the organization and performance of high school, college, and community choruses. Techniques of choral conducting and rehearsal, repertory, and materials. 2 cr.

843. Materials and Methods in Piano Music
Cives 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.

983. Instrumental Literature and Its Performance
Exploration of representative solo and ensemble music for string, wind, and percussion instruments. Typical literature from each period of music is studied. As much as is possible, live performance is included; recordings are used as required. Detailed attention given to interpretation. Project required. 3 cr.

984. Choral Literature and Its Performance
Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students have the opportunity to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college repertoires. 3 cr.

995. Special Projects in Music Education
Independent study, investigation, or research in music education. Creative projects may be included. Prereq: permission. 1–4 cr.

996. Foundations and Perspectives of Music Education
Philosophical, sociological, and psychological foundations and principles of music education and the relationship of these principles to music learning and teaching. 4 cr.

Department of 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
Adjunct Professor: Robert S. Pierce
Associate Professors: Robert T. Eckert; Theodore E. Howard; John A. Litvaitis; R. Marcel Reeves; Barrett N. Rock; C. Tattersall Smith; Richard R. Weyrick
Research Associate Professor: Frederick T. Short
Adjunct Associate Professors: C. Anthony Federer; James W. Hornbeck; William B. Leak; Sidney A. L. Pilgrim; Lawrence O. Safford
Assistant Professors: William B. Bowden; Christine V. Evans; Donald G. Hodges; William H. McDowell; Peter J. Pekins
Research Assistant Professor: Stephen H. Jones
Adjunct Assistant Professor:Peter W. Garrett
Graduate Program Coordinator: Robert D. Harter

Degrees Offered

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

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

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

Wildlife: habitat evaluation and management, wildlife energetics, and land-use planning for wildlife.

Admission Requirements

Applicants are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. All entering students must have taken at least one statistics course or do so at the graduate level. The Graduate Record Examination general test may be required of some applicants.

Students entering the forestry program may elect to develop concentrations within forest management or forest/wood science. Students with a forest management emphasis are usually expected to have completed a bachelor's degree in forestry equivalent to that obtained at a school accredited by the Society of American Foresters. Students with a forest science or wood science interest should have an appropriate background for study in the specific interest area. Entering students in soil science are required to have adequate preparation in the physical sciences as well as biological or earth sciences. Students interested in wildlife are expected to have adequate preparation in biological sciences, chemistry, and mathematics.

M.S. Degree Requirements

An M.S. degree is conferred upon successful completion of the following: (1) A program amounting to not less than 30 credits, including the following course requirements or equivalent: 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 92) 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 77) is available to students in forestry through the genetics

program and a Ph.D. in environmental chemistry (see page 48) is available to soil science 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)

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.

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

857. Basics of Remote Sensing
Fundamentals for application of photographic and nonphotographic sensors to information gathering in natural resource fields; emphasis is on the interpretation of aerial photographs. Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Special fee. Lab. 3 cr.

858. Aerial Terrain Analysis
Visual interpretation of aerial and satellite imagery for study of landform, geology, hydrology, vegetation, and cultural patterns; applications in U.S. geography. Prereq: NR 857 or equivalent; binocular vision an advantage. Special fee. Lab. 2 cr.

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

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

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.

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 characters, quantitative data analysis. Prereq: prin. of genetics; silviculture; statistics; or permission. Special fee. Lab. 3 cr. (Not offered every year.)

822. Advanced Silviculture
Intensive silviculture of forest stands. Regeneration (e.g., alternative regeneration methods and site preparation); stand management (e.g., thinning schedules and fertilization). Prereq: silviculture; permission. Special fee. 3 cr. (Not offered every year.)

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, stand 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:
A) Forest Ecology; B) Remote Sensing; C) Wood Products; D) Mensuration; E) Forest Economics; F) Forest Management; G) Operations; H) Recreation; I) Policy; J) Forest Genetics; K) Watershed Management. Prereq: permission. 1–4 cr.

Soil Science (SOIL)

802. Chemistry of Soils
Chemical composition of soil; colloidal phenomena and the exchange and fixation of elements; cation exchange capacity and source of negative charge; inorganic reactions in soil and their effect on soil properties. Prereq: one year of college chem. or permission. 3 cr.

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

805. Forest Soils
Basic ecological and management perspectives; soil-site quality evaluation; forest land classification and interpretation; forest soil management techniques. Prereq: basic soils course; or permission. Special fee. Lab. 4 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.

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, nongame, and fur bearers. Prereq: permission. Special fee. 4 cr.

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

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

Natural Resources Program (NRP)

Chairperson: John Aber
Professors: John Aber; S. Lawrence Dingman; Robert C. Harriss; Robert O. Harter; Dennis Meadows
Associate Professors: Robert T. Eckert; Richard W. England; Theodore E. Howard; Barrett N. Rock
Assistant Professors: William B. Bowden; Donald G. Hodges

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 multidisciplinary 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 course work 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. Course work done at the master's level is, with appropriate approvals, counted against credit hour requirements for the degree.

Ph.D. Degree Requirements

The total course work requirement is 48 credits, of which only 12 may be in project and seminar courses. This total may be reduced to 36 with the approval of the program's Executive Committee and the Graduate School. Graduate-level course work in master's degree programs and from other universities may be applied to this requirement. All students in the program take courses in four core areas: concepts of natural resources management, problems in natural resources management, experimental design, and seminar. Additional course requirements will be determined by the doctoral committee and the program.

Each student must take three written examinations: 1) a written qualifying exam, which covers the basic concepts and factual material deemed essential for the student by the doctoral committee; 2) a preliminary exam, which covers the student's proposed dissertation research topic; and 3) an oral exam, which covers the results of the student's dissertation research (eligibility to take this exam is dependent on the student's completion of a dissertation acceptable to the doctoral committee).

All students are required to demonstrate proficiency in one foreign language or one computer programming language.

Students are advanced to candidacy after successfully completing the written qualifying exam, the oral preliminary exam, and the foreign or computer programming language requirement.

995. Independent Study
1–4 cr.

999. Doctoral Research

Nursing (NURS)

Chairperson: Marie P. Farrell
Professors: Marie P. Farrell; Judith A. Sullivan
Associate Professors: Karen R. Johnson; Juliette D. Petillo; Dorothy D. Rentschler; Raelene Shippee-Rice; Margaret W. Spears; Rosemary Y. Wang; Carol L. Williams
Assistant Professors: Sarah Jo Brown; Gene E. Harkless; Kathryn R. Lynch; Eileen F. Morrison
Graduate Program Coordinator: Judith A. Sullivan

Degree Offered

The Department of Nursing offers the master of science degree in nursing. Two specialty areas are offered: adult health nursing and nursing administration.

Admission Requirements

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. It is designed to be completed within two academic years of full-time study. Individualized plans of study are available for those wishing to pursue part-time study. The program of study is designed as follows:

1) *Core courses (12 credits):* Courses required of all students include (a) foundation and role courses (8 credits): 900, The Discipline of Nursing; 901, The Changing Role of Professional Nursing and the Health Care Systems; 904, Role Development Seminar; and (b) research courses (4 credits): 902, Research in Nursing I and 903, Research in Nursing II.

2) *Specialty courses (18 credits):* Courses required for each area of specialization include, for adult health nursing: 910, Advanced Nursing Concepts in Adult Health; 911, Clinical Decision Making in Nursing; 912, Advanced Practice of Nursing in Adult Health; 919, Role Practicum and Seminar in Nursing Care of Adults; and 920, Administrative Theories of Nursing. For nursing administration: 910, Advanced Nursing Concepts in Adult Health; 920, Administrative Theories of Nursing; 921, Administrative Context for Quality Nursing Care Delivery; 922, Resource and Financial Management in Nursing; and 929, Role Practicum and Seminar in Nursing Administration.

3) *Elective courses (3–6 credits):* Three or six credits of elective coursework are required based upon the student's choice of master's thesis or project option. If the project is taken for three credits, the student will select a three-credit elective associated with and supportive of the project.

4) *Master's thesis (6 credits) or master's project (3–6 credits):* A student may elect either a thesis or nonthesis option. A formal presentation of the completed project or thesis is required.

900. The Discipline of Nursing
Nursing as a discipline with a focus on paradigms for nursing science, patterns of knowing, concept analysis, and nursing theory. Emphasis on concepts fundamental to nursing practice, including advocacy, caring, power, and collaboration; analysis of nursing theories in relation to practice and research. Prereq: permission. 3 cr.

901. The Changing Role of Professional Nursing and the Health-Care System
Examination of issues affecting the practice of contemporary nursing. Emphasis on the systematic analysis of nursing and health-care system problems from multiple vantage points including historical, social, political, economic, legal, and ethical perspectives. Students present the strengths and limitations of current proposed solutions to specific problems in health policy, such as entry into nursing practice, indigent health-care policy, and the role of the nurse as advocate. Students then construct new approaches to the problems and argue their merits. Prereq: permission. 3 cr.

902. Research in Nursing I
Overview of current research in nursing. Importance of research for the development of a professional discipline and the importance of understanding ethical issues for the researcher, practitioner, and consumer. Emphasis on quantitative research methodologies and appropriate research designs for selected clinical questions. Pre- or coreq: NURS 900 or permission. 2 cr.

903. Research in Nursing II
Introduction to dominant paradigm and new paradigm qualitative nursing research methods including sampling, data collection, analysis, evaluation, utilization, and communication. Ethical implications and the nature of the research-participant relationship are addressed. Prereq: NURS 902 or permission. 2 cr.

904. Role Development Seminar
Analysis of role development and role enactment in professional nursing practice. Focus on roles related to specialization including those of advocate, researcher, educator, and consultant. Prereq: NURS 900 or permission. 2 cr.

910. Advanced Nursing Concepts in Adult Health
Theoretical course investigating the major health problems among adults. Focus on theory and research pertaining to selected concepts and those dimensions critical to nursing practice. Pre- or coreq: NURS 900 or permission. 3 cr.

911. Clinical Decision Making in Nursing
In-depth analysis of client health problems, integrating theoretical, ethical, empirical, and interpretive perspective leading to the development of an assessment data base for nursing diagnosis, intervention, and evaluation. Emphasis on clinical decision making and application of nursing theories to practice. Prereq: NURS 900; 910;/or permission. 3 cr.

912. Advanced Practice of Nursing in Adult Health
Application of nursing diagnoses and clinical management of health problems of adult populations. Analysis of theories and concepts applicable to nursing interventions. Emphasis on research-based clinical nursing practice. Prereq: NURS 911. 3 cr.

919. Role Practicum and Seminar in Nursing Care of Adults
Role development preceptorship in the clinical setting; integration of consultation, patient education, and research into specialist role. Seminar directed at evaluation of the effectiveness and appropriateness of theories in practice. Interactive learning opportunities for students in clinical specialization and nursing administration. Prereq: permission. 6 cr.

920. Administrative Theories in Nursing
Exploration of administrative theories and organizational behavior concepts. Application of administrative theory to the practice of nursing administration in current and emerging health care settings. Role of the nurse executive and issues facing women in management are examined. Pre- or coreq: NURS 900 or permission. 3 cr.

921. Administrative Context for Quality Nursing Care Delivery
Examination of administrative context of nursing practice and the impact of internal and external forces. Identification of strategies to achieve efficient and effective quality nursing care. Focus on creating a climate that enhances nursing practice, education, and research. Prereq: 920 or permission. 3 cr.

922. Resource and Financial Management in Nursing
Focus on theories and concepts that promote the effective utilization of human and financial resources in nursing organizations. Introduction to principles of budgetary and financial planning needed for effective nursing administration. Analysis of concepts and principles of administration, supervision, and consultation. Prereq: NURS 920 or permission . 3 cr.

929. Role Practicum and Seminar in Nursing Administration
Role development preceptorship in the clinical setting; integration of consultation, patient education, and research into specialist role. Seminar directed at evaluation of the effectiveness and appropriateness of theories in practice. Interactive learning opportunities for students in clinical specialization and nursing administration. Prereq: permission. 6 cr.

994. Special Topics
Formal courses given on selected topics or special interest subjects. Several topics may be taught in one year or semester. May be repeated. Prereq: permission. 1–3 cr.

996. Independent Study
Opportunity for study and/or practice in an area of choice. Objectives are developed by students and must be approved by faculty. May be repeated for a maximum of 6 credits. Prereq: permission. 1–3 cr.

898. Master's Project
Opportunity to develop, implement, and evaluate a project relevant to the practice setting. Prereq: permission. Variable 1–6 crs. (Total must equal 3 or 6 cr.) An "IA" course. Cr/F.

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

Occupational Education (AOE)

Program Coordinator: David L. Howell
Professors: William H. Annis; David L. Howell
Associate Professors: Peter J. Horne; Lewis Roberts, Jr.
Assistant Professor: Patricia D. Dugan-Bedker

Degree Offered

The program in occupational education offers the master of occupational education degree. Graduate students can select one of two areas of concentration: (a) vocational/technical education; or (b) adult education.

Admission Requirements

Applicants should consult with a faculty member before seeking admission, since an applicant's scholastic achievement, experience, references, and professional goals are all relevant in the admission process. Applicants must also submit scores achieved on either the Graduate Record Examination, general test, or the Miller Analogies Test, in addition to the materials required by the Graduate School.

Master of Occupational Education Degree Requirements

All students are required to take 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. 1–2 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: microteaching. 4 cr.

896. Investigations in Adult and Occupational Education
A) Career Education; B) Secondary Education; C) Post-Secondary Education; D) Adult Education; E) Extension Education; F) Exemplary Programs; G) Cooperative Education Programs; H) Disadvantaged and Handicapped Education Programs. Student-selected problems in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. May be repeated. 2–4 cr.

900. College Teaching
An analysis of teaching strategies at the collegiate level. The planning, execution, and evaluation of instruction for meeting the needs of the young adult learner. Recommended for all who wish to teach in a collegiate setting. Discussion of lectures of selected, distinguished UNH lecturers. Prereq: permission. 2 cr.

901. Advanced Methods and Materials of Instruction
Organization and delivery of performance-based instruction. Provides opportunities for exploration in instructional planning, execution, evaluation, management, and guidance. Open to teachers of vocational/technical education and others by permission. Required of master's degree candidates concentrating in vocational/technical education. 4 cr.

903. Administration and Supervision of Vocational Education
Students identify and develop competencies required of vocational administrators, using a vocational administrator task analysis, which includes fair hiring and firing practices, staff development, long-range planning, federal ad-

ministration for vocational programs, and evaluation of program effectiveness. Philosophy of, and federal regulations governing, vocational education. 4 cr.

904. Planning Strategies in Vocational/Technical Education
A systematic approach to the development of course materials for vocational/technical education. Topics included are occupational analysis, establishing performance objectives, selection of content, development of supplemental material, and evaluation. Prereq: a course in teaching methods or permission. 4 cr.

905. The Development of Cooperative Education Programs
Organization and development of cooperative training programs. Designed for teachers, cooperative-education coordinators, work-study coordinators, school administrators, industrialists, and others in charge of external training programs. Focus on planning, implementation, and evaluation of cooperative training programs as they relate to the role and function of the organization. 4 cr.

906. Developing Vocational Programs for Special Needs Learners
Designed for teachers and administrators in vocational education who are working with or preparing to work with disadvantaged and/or handicapped individuals. Focus on issues associated with planning, developing, implementing, and evaluating vocational programs for special needs learners. 4 cr.

908. Introduction to Vocational Assessment in Secondary School
Provides an overview of vocational evaluation and an in-depth look at informal vocational assessment. Designed for teachers. Topics include the occupational cluster system, assessment techniques, behavioral analysis, and work sampling. 4 cr.

909. Community Organization and Public Relations
The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their membership to the general welfare of the area and the development of a public relations program. 4 cr.

911. Internship
Internship in a field of vocational/technical and adult education either in methodology of teaching or technical subject matter. Students may elect internship only after completing the qualifying examinations for the master's degree, with permission of their major adviser. May be repeated up to 8 cr. 0–8 cr.

912. Introduction to 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)

Coordinator: Kenneth C. Baldwin
Professors: Wendell S. Brown; Robert W. Corell; Stephen S.T. Fan; Albert D. Frost; David E. Limbert; Godfrey H. Savage; Kondagunta Sivaprasad
Associate Professors: Kenneth C. Baldwin; Thomas P. Ballestero; Jean Benoit; Barbaros Celikkol; Pedro A. de Alba; Allan D. Drake; David L. Gress; Nancy E. Kinner; Donald W. Melvin; M. Robinson Swift

Degree Offered

The interdisciplinary ocean engineering program offers graduate work leading to the degree of master of science in ocean engineering. The general purpose of this program is to prepare engineering students for professional careers in ocean-related fields.

Admission Requirements

Applicants to the program should have completed a baccalaureate degree in either chemical, civil, electrical, or mechanical engineering or have an equivalent background.

M.S. Degree Requirements

Each student in the program is required to take ESCI 858, Introductory Physical Oceanography and OE 990, 991, Ocean Engineering Seminar I, II. In addition, each student must select three of the following six courses: OE 881, Physical Instrumentation; OE 810, Ocean Measurements Laboratory; OE 853, Ocean Hydrodynamics; OE 854, Ocean Waves and Tides; OE 885, Underwater Acoustics; and ESCI 959, Data Analysis Methods in Ocean and Earth Sciences. Students are also required to take a minimum of 12 credits of additional coursework and complete a master's thesis for 6 credits. Normally the additional courses are in the student's field of engineering.

810. Ocean Measurements Laboratory
Measurements of fundamental ocean processes and parameters. Emphasis on understanding typical offshore measurements, their applications, and the use of the acquired data. The latter is in terms of the effects on structures and processes in the ocean. 4 cr.

851. Naval Architecture in Ocean Engineering
Selected topics in the fundamentals of naval architecture pertinent to ocean engineering; including hydrostatic characteristics; basics of resistance and propulsion; and rules and regulations for surface, semisubmersible, and submersible marine vehicles. Computer applications. Prereq: fluid dynamics; mechanics;/or permission. (Also offered as ME 851.) 4 cr.

852. Submersible Vehicle Systems Design
Conceptual and preliminary design of submersible vehicle systems; submersibles, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects selected and completed by student teams. Prereq: permission. (Also offered as ME 852.) 4 cr.

853. Ocean Hydrodynamics
Fundamental concepts of fluid mechanics as applied to the ocean; continuity; Euler and Navier-Stokes equations; Bernoulli equation; stream function, potential function; momentum theorem; turbulence and boundary layers are developed with ocean applications. Prereq: permission. 3 cr.

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

857. Coastal Engineering and Processes
Introduction to small-amplitude and finite-amplitude wave theories. Wave forecasting by significant wave method and wave spectrum method. Coastal processes and shoreline pro-

tection. Wave forces and wave structure interaction. Introduction to mathematical and physical modeling. Prereq: fluid dynamics or permission. (Also offered as CIE 857 and ME 857.) 3 cr.

861. Materials in the Ocean
Introduction to mechanical properties of materials; ferrous metals; nonferrous metals; concrete, plastic, wood, etc.; corrosion of metals; corrosion control; durability of cementitious materials; degradation of plastics, wood, etc. in marine environment; proper materials selection for a marine environment. Prereq: permission. 3 cr.

881. Physical Instrumentation
Analysis and design of instrumentation systems. Sensors, circuits, and devices for measurement and control. Elements of probability and statistics as applied to instrument design and data analysis. Transmission, display, storage, and processing of information. The design, implementation, testing, and evaluation of an instrument system is an integral part of the course. Prereq: permission. (Also offered as EE 881.) 4 cr.

885. Underwater Acoustics
Vibrations; propagation; reflection; scattering; reverberation; attenuation; sonar equations; ray and mode theory; radiation of sound; transducers; and small- and large-signal considerations. Prereq: permission. (Also offered as EE 885.) 4 cr.

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

937. Advanced Hydrodynamics
Continuum approach to the analysis of ocean circulation problems. Shallow and deep water modeling to include temperature, salinity, and species distributions in time and space. Air-sea interaction, energy transport phenomena, internal currents, and the effect of coastal geometry on wave reflection and resonant phenomena. Fundamental data acquisition and analysis techniques. Prereq: permission. 4 cr.

990, 991. Ocean Seminars I, II
Various topics, including marine systems design, marine vehicle operation, data collecting and processing, and marine law. 2 cr.

998. Independent Study
Independent theoretical and/or experimental investigation of an ocean engineering problem under the guidance of a faculty member. 1–4 cr.

899. Master's Thesis
6 cr.

Physical Education (PHED)

Chairperson: Stephen H. Hardy
Professor: Robert Kertzer
Associate Professors: Katherine Amsden; Ronald C. Croce; Michael A. Gass; Stephen H. Hardy; Neil B. Vroman; Walter E. Weiland
Assistant Professors: Timothy J. Quinn; Sally A. White
Graduate Program Coordinator: Sally A. White

Degree Offered

The Department of Physical Education offers a master of science degree with the following areas of concentration: exercise science, sport studies, and special physical education.

Admission Requirements

Admission is based on undergraduate preparation, academic record, Graduate Record Examination general test scores, and letters of recommendation. Applicants must be above-average students and show adequate preparation in the basic support courses of the selected concentration area. Applicants who have not met specific course prerequisites should expect to take additional undergraduate work without receiving graduate credit.

M.S. Degree Requirements

Students in the exercise science concentration must follow the thesis plan; students in the sport studies and the special physical education concentrations may follow either the thesis or the nonthesis plan. All degree candidates will be required to take 800, Applied Statistics; 901, Analysis of Professional Literature; the designated concentration core; and electives as required.

Exercise science core: 822, Graded Exercise Testing and Exercise Prescription; 832, Electrocardiography; 833, Environmental Physiology; two semesters of 902, Colloquium.

Sport studies core: 841, Sport in Society; 880, Psychological Factors in Sport; and one adviser-approved PHED elective at the 800 or 900 level.

Special physical education core: 902, Colloquium; 909, Special Physical Education Practicum/Seminar; 842, Diagnostic Motor Assessment; 844, Medical and Exercise Issues of Disabling Conditions; and 12 credits of adviser-approved electives.

Any remaining coursework in the concentrations should be taken within the Department of Physical Education; however, approval may be granted to take relevant courses outside the department.

Thesis plan: A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) is required in the thesis plan plus an oral defense of the thesis.

Nonthesis plan: A minimum of 8 approved graduate courses (with a minimum of 30 credits) is required in the nonthesis plan. Four credits of 895, Advanced Studies, are required. A student may take 895 only after completing at least three approved graduate courses including 901.

800. Applied Statistics
Statistical procedures and associated elements of basic research design with direct, practical application to areas within physical education and other health disciplines. Prereq: measurement procedures or equivalent. 4 cr.

806. Neurology
Morphology, physiology, and histology of the human nervous system. Prereq: human anatomy and physiology. Lab. Special fee. 4 cr.

822. Graded Exercise Testing and Exercise Prescription
Graded exercise testing and its application to the prescription of exercise. Special emphasis on the patient with cardiovascular disease. Prereq: physiology of exercise; permission. 4 cr.

823. Exercise Epidemiology
Considers the hazards and benefits of exercise, physical activity, and physical fitness in relation to health from an epidemiological perspective. Prereq: physiology of exercise. 4 cr.

825. Motor Control Issues in Motor Dysfunction
Examination of normal and pathological movement patterns; important anatomical, physiological, and biomechanical variables constraining movement organization; and 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.

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, cardio-respiratory, 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.

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. 2–4 cr.

901. Analysis of Professional Literature
Critical interpretation of professional literature. 4 cr.

902. Colloquium
A seminar format involving presentation and discussion of current topics in exercise physiology. Two semesters are required for students in the exercise specialist concentration. 1 cr. Cr/F.

903. Internship
Clinical work, normally in a hospital or laboratory setting, involving exercise physiology, graded exercise testing, exercise prescription and/or cardiac rehabilitation. Open only to exercise science students who have completed all required coursework except thesis. 4 cr. Cr/F.

909. Special Physical Education Practicum/ Seminar
Prepares master teachers to employ many teaching skills so that they can interact effectively in educational environments. Methods for a special physical education teacher to design and implement an educational program for children with disabilities that is congruent with the idiosyncrasies of a realistic school situation. 2 cr. Cr/F.

960. Application of Research to Teaching and Coaching
The application to coaching and teaching physical education of pertinent research findings in sport psychology, sport sociology, exercise physiology, biomechanics and kinesiology, and motor learning and development. Prereq: measurement procedures in physical education or equivalent; permission. 4 cr.

899. Master's Thesis
6 cr.

Physics (PHYS)

Chairperson: John R. Calarco
Professors: Roger L. Arnoldy; L. Christian Balling; John R. Calarco; Edward L. Chupp; John F. Dawson; Lennard A. Fisk, Jr.; Jochen Heisenberg; Joseph Hollweg; Richard L. Kaufmann; Robert H. Lambert; Martin A. Lee; John E. Mulhern, Jr.; Harvey K. Shepard; Robert E. Simpson; John J. Wright
Research Professors: Terry Forbes; William R. Webber
Associate Professors: Olof Echt; F. William Hersman; Eberhard Möbius; Roy B. Torbert
Research Associate Professors: David J. Forrest; James M. Ryan, W. T. Vestrand
Assistant Professor: Dawn C. Meredith
Research Assistant Professor: Craig A. Kletzing
Graduate Program Coordinator: L. Christian Balling
Graduate Program Recruiter: Harvey K. Shepard

Degrees Offered

The Department of Physics offers the degrees of master of science, master of science for teachers, and the doctor of philosophy. Areas of specialization are space physics and astrophysics, nuclear physics, atomic and molecular physics, and nonlinear dynamical systems.

Admission Requirements

Applicants for the degree of master of science for teachers must hold secondary school teacher certification in physics or in general physical science.

Applicants to the master of science and doctor of philosophy programs are expected to have a bachelor's degree in science, with at least 24 credits in physics and closely allied fields.

M.S. Degree Requirements

The courses required for the master of science in physics include PHYS 805, 931, 939, 941, and 943. Students may select one of the following plans:

1) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.
2) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of 6 semester hours' work, and pass an oral examination on the thesis.

Master of Science for Teachers Degree Requirements

The courses leading to this degree will be chosen to improve candidates' ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics.

M.S.T. students are not required to take the qualifying examination. Teaching experience is required for this degree. Persons interested in this degree should confer with the graduate adviser.

Ph.D. Degree Requirements

The courses required for a doctor of philosophy degree in physics are (1) 805, 931-932, 935, 939-940, 941-942, 943-944; and (2) any additional four full courses at the 900 level, excluding 969, 989, 997, and 999. (For students doing Ph.D. research in astrophysics or space physics, one of these four courses must be 951 or 952.)

Admission to candidacy for the degree is based primarily upon demonstrated ability in formal coursework; experience in teaching, equivalent to at least half time

for one year; and passing a written qualifying examination. This examination is normally taken during the second year. Exceptions to the timing are possible only by petition. Students are allowed a total of two attempts to achieve candidacy. Upon completion of a dissertation, doctoral candidates will take an oral examination based upon the area of their research.

Interdisciplinary Research

The department encourages research in areas related to physics or applied physics. Should students desire to do research in a field related to physics, special provisions may be made. A cooperative program with the Department of Electrical and Computer Engineering is available to master's students in physics. Physics students specializing in space science may complete M.S. or Ph.D. theses under the guidance of professors or research professors in the Institute for the Study of Earth, Oceans, and Space. (See EOS.) Contact the department chairperson or graduate adviser for details.

801-802. Introduction to Quantum Mechanics I and II
Nonrelativistic Schroedinger equation, the hydrogen atom, applications to atomic and nuclear structure. Prereq: diff. equations; multidim. calculus;/or permission. Intro. mathematical physics course desirable. 4 cr.

803-804. Electricity and Magnetism I and II
Foundation of electromagnetic theory; electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory. Prereq: diff. equations; multidim. calculus;/or permission. Intro. mathematical physics course desirable. 4 cr.

805. Experimental Physics
Modern research techniques, including discussion and laboratory exercises in nuclear and atomic phenomena. Prereq: passing an electronics proficiency test or basic experimental physics. May be repeated to 6 credits. 3 cr.

807. Computational Physics
Application of numerical methods to physics, including integration of ordinary and partial differential equations, matrix methods, Fast Fourier transforms, and quadrature. Prereq: knowledge of a high level programming language (e.g., FORTRAN, C, or PASCAL), diff. equations with linear algebra; gen. physics I and II, gen. physics III and IV, and intro. to mathematical physics. 4 cr. (Not offered every year.)

810. Introduction to Astrophysics
Review of the sun, stars, Milky Way, external galaxies, and expansion of the universe. Recent discoveries of radio galaxies, quasi-stellar objects, cosmic black-body radiation, x-rays, and gamma rays precede a discussion of Newtonian and general relativistic cosmological models, steady-state/big-bang theories, and matter-antimatter models. Prereq: phys. mechanics; diff. equations;/or permission. 4 cr.

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. 3 cr. (Not offered every year.)

818. Introduction to Solid State Physics
Theory underlying the behavior of solids. Transport theory and the interaction of radiation and matter. Operation of semiconducting and superconducting devices and lasers. Prereq: physical mechanics, intro. quantum mechanics; diff. equations, multidim. calculus. 4 cr. (Not offered every year.)

895. Independent Study
Individual project under direction of a faculty adviser. Prereq: department permission. 1–8 cr.

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

935. Statistical Physics
Review of thermodynamics and kinetic theory, followed by an introduction to classical and quantum statistical mechanics. Microcanonical, canonical, and grand canonical ensembles; ideal Fermi and Bose gases and applications of statistical mechanics to selected physical problems. Prereq: PHYS 931; PHYS 943;/or permission. 3 cr.

939-940. Theoretical Mechanics I and II
Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies; continuum mechanics. Topics that serve as background for the study of modern physical theories are emphasized. 3 cr.

941-942. Electromagnetic Theory
The formulation and detailed application of electromagnetic theory to physical problems. Prereq: permission. 3 cr.

943-944. Quantum Mechanics
Wave mechanical and Dirac formulations of nonrelativistic quantum mechanics. Prereq: permission. 3 cr.

951-952. Plasma Physics I and H
Kinetic theory of plasmas; plasma waves, instabilities, turbulence, diffusion, adiabatic motion of charged particles, nonlinear plasma phenomena. Prereq: PHYS 935 or permission. 3 cr. (Not offered every year.)

953. Solar Magnetohydrodynamics
Introduction to solar physics, with emphasis on gas dynamics and magnetic fields. Interior structure, the theory of convection, wave motions in the presence of magnetism and gravity, coronal heating theories, steady and nonsteady flows, dynamo theory, and the theory of solar flares and other transient phenomena. Salient observational data will be reviewed. Prereq: permission. 3 cr. (Not offered every year.)

954. Solar Wind and Cosmic Rays
The solar wind and its effects on cosmic rays. The basic equations of the solar wind: mass, momentum, angular momentum, and energy balance. CGL theory. Transport processes. Waves, shocks, and instabilities in the solar wind. The basic equations of cosmic ray transport. Solar modulation of solar and galactic cosmic rays. Interaction of cosmic rays with shock waves. Salient data are reviewed. Prereq: permission. 3 cr. (Not offered every year.)

961-962. Advanced Quantum Mechanics
Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. Prereq: PHYS 939; PHYS 944. 3 cr. (Not offered every year.)

963-964. Nuclear Physics
Introduction to nuclear processes including nuclear forces, nuclear structure and models, static properties, beta and gamma emission, and nuclear reactions. Selected topics in experimental methods. Prereq: PHYS 944. 3 cr. (Not offered every year.)

965. Solid State Physics
Development of quantum mechanical theory of solids, transport phenomena, etc. Prereq: PHYS 943; PHYS 935. 3 cr. (Not offered every year.)

969. Nuclear Physics Seminar
Lectures and discussion of current topics in nuclear and particle physics. 1–3 cr.

987, 988. Introduction to Space Science I and II
Topics are selected from the following: ionospheric physics; magnetospheric physics; interplanetary physics; solar physics; cosmic-ray physics; radio, x-ray, and gamma-ray astronomy; motion, transport, energy loss, origin, and acceleration of charged particles in the magnetosphere; interplanetary medium and galaxy; cosmological problems. 3 cr. (Not offered every year.)

989. Space Physics Seminar
Lectures and discussions of current research in the physics of fields and particles in space. May be repeated to 6 credits. 1–3 cr.

991. Problems in Theoretical Physics
May be repeated to six credits. 1–3 cr. (Offered on request.)

993. Problems in Experimental Physics
May be repeated to six credits. 1–3 cr. (Offered on request.)

995. Special Topics
Any special fields of study not covered by the

above courses may be included. Topic choices in previous years: astrophysics; elementary particles; lasers/masers; many-body theory; general relativity and cosmology; group theory; atomic physics; quantum theory of light, nonlinear equations, and chaos. May be taken more than once. 1–3 cr.

997. Colloquium
Required of all graduate students. Topics to be selected. 0 cr.

899. Master's Thesis
6 cr.

999. Doctoral Research

Plant Biology (PBIO)

Chairperson: Curtis V. Givan
Professors: Robert O. Blanchard; A. Linn Bogle; Garrett E. Crow; George O. Estes; Curtis V. Givan; Yun-Tzu Kiang; J. Brent Loy; William E. MacHardy; Arthur C. Mathieson; Subhash C. Minocha; Lincoln C. Peirce; Owen M. Rogers; Douglas G. Routley; Otho S. Wells
Associate Professors: Alan L. Baker; Thomas M. Davis; Wayne R. Fagerberg; Leland S. Jahnke; Thomas D. Lee; James R. Mitchell; James E. Pollard; John M. Roberts
Graduate Program Coordinator: Thomas D. Lee

Degrees Offered

The Department of Plant Biology offers the master of science and the doctor of philosophy degrees. Research opportunities are available in both basic and applied areas of plant biology, including breeding and genetics, cell biology, cell and tissue culture, crop management, ecology, plant molecular biology, genetic engineering, marine and freshwater biology, morphology and anatomy, mycology, pathology, phycology, physiology, and systematic botany.

Admission Requirements

Applicants are expected to have adequate preparation in plant biology and in the physical sciences; they must also submit general and subject biology scores for the Graduate Record Examination.

M.S. Degree Requirements

Students will meet the Graduate School's requirements for the degree. Students will be required to write and defend a thesis based on field or laboratory research and pass a comprehensive examination.

Ph.D. Degree Requirements

Students will complete a program of study as determined by their guidance committee. Students will be advanced to candidacy after successfully completing comprehensive written and oral qualifying examinations. Candidates must successfully defend a dissertation based on original research in plant biology. For some program areas, a foreign language may be required at the discretion of the student's guidance committee.

Teaching Requirements

Teaching experience is required of all M.S. and Ph.D. degree students. The 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.)

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; including shadow casting and photographic techniques, and presentation of micrographs for publication. Prereq: permission. Coreq: PBIO 815. 2 cr.

815. Electron Microscopy Lab
Practical application of theoretical principles and practices utilized in preparing and observing plant and animal tissues with the transmission and scanning electron microscopes. Student project assigned. Prereq: permission. Coreq: PBIO 814. 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 lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: general limnology or permission. (Also offered as ZOOL 819.) Lab. 4 cr.

821. The Microscopic Algae
Survey of phytoplankton and periphyton in local marine and freshwater habitats. Identification, systematics, and evolution. Class and individual collection trips. Prereq: elem. bot. or survey of the plant kingdom. Lab. 4 cr.

822. Marine Phycology
Identification, classification, ecology, and life histories of the major groups of marine algae, particularly the benthonic marine algae of New England. Periodic field trips. Prereq: elem. bot. or survey of the plant kingdom. Lab. 4 cr. (Not offered every year.)

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 are desirable. 4 cr. (Not offered every year.) (Also offered as ZOOL 825.)

827. Algal Physiology
Survey of major topics in the physiology and biochemistry of marine and fresh water algae including nutrition, metabolic pathways, reproductive physiology, storage and extracellular products, cell inclusion, growth and development. Prereq: plant physiology and intro. biochem. or permission. 2 cr. (Not offered every year.)

829. Algal Physiology Laboratory
Laboratory techniques useful in studying the physiology of freshwater and marine algae. Experiments in nutrition, metabolism, pigment and enzyme analysis. Small research project required. Prereq: permission. Coreq: PBIO 827. 2 cr. (Not offered every year.)

832. Cell Biology
The cell concept and the relationship of cell structure to function. The importance of cell-to-cell communication, replication, and the factors controlling cell structure in the function of

the whole organism. Major tools used by the cell biologist to study cells. Prereq: one year of biology and an intro. chem. course. 4 cr.

840. Evolutionary Biology
Origin of source of genetic variation; population structure, mechanisms of evolution; molecular evolution; ecological adaptation in animals, plants, and humans; community structure and evolution. Prereq: prin. of genetics or permission. (Also offered as GEN 840.) 4 cr. (Not offered every year.)

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.) Lab. 4 cr.

852. Mycology
Classification, identification, culturing, life histories, and ecology of parasitic and saprophytic fungi; their role in the environment and human affairs. Prereq: elem. bot. Lab. 4 cr.

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

858. Plant Anatomy
Anatomy of vascular plants; structure and development of basic cell and tissue types and the major organs of woody plants. Prereq: intro. bot. or survey of the plant kingdom or prin. of biol.; permission. 5 cr.

861. Plant Geography
Distribution of plants, a consideration of world vegetation types and floras, with emphasis on North America. Major influential factors such as geologic, climatic, edaphic, and biotic. Includes such topics as island biogeography, continental drift, and the historical development of floras from the Tertiary through the Pleistocene to major floras of today. Prereq: plant taxonomy or permission. 4 cr. (Not offered every year.)

862. Morphology of the Seed Plants
Comparative form and structure of the major living and extinct groups; evolutionary modifications of the vegetative and reproductive organs, and the basic life history pattern. Prereq: survey of the plant kingdom or prin. of biol. Lab. 4 cr. (Not offered every year.)

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

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

868. Optical Microscopy and Photomicrography
Theory and techniques for the optimal use of the optical microscope, including bright field and dark field modes; various types of condensers; camera equipment; films, filters, and photographic techniques. Prereq: permission. Special fee. Lab. 4 cr.

871. Computer Applications in Biology
A set of 2-credit modules. Module A, first half of semester. Module B, second half of semester. Module A prerequisite to Module B.

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

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

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

874. Plant Cell Culture and Genetic Engineering
Theory and techniques of cell/tissue culture and genetic manipulation in plants, transformation vectors, somatic cell genetics, regulation of foreign gene expression, molecular basis of agriculturally important traits, environmental and social implications of genetic engineering in plants. Prereq: genetics or permission. Coreq: PBIO 875. (Also offered as GEN 874.) 3 cr. (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. (Also offered as GEN 875.) Coreq: PBIO 874. Special fee. 2 cr. (Not offered every year.)

876. Radiation Biology
Nature, sources, and behavior of ionizing radiation and its interaction with biological systems. Detection, measurement, and dosimetry techniques. Radiation effects on cells, organs, and organisms. Radiotracer techniques in biological research and medicine. Terrestrial and marine radioecology; pathways through the food chain. Environmental radioactivity, nuclear power, weapons systems, and waste disposal. Lab. 4 cr.

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.

922. Advanced Marine Phycology
Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussion, assigned reading, and laboratory. Prereq: marine phycology or equivalent. 4 cr.

959. Advanced Mycology
Biology, isolation, and identification of fungi treated at an advanced level. Assigned readings and a collection required. Prereq: mycology or equivalent. Lab. 4 cr. (Not offered every year.)

977. Supervised Teaching for Graduate Students
Students plan and present lectures, recitations, and/or teach laboratories in selected plant biology courses with faculty supervision and evaluation. Prereq: permission. 1–3 cr. Cr/F.

985. Advanced Topics in Plant Biology
Discussions of current topics in selected areas of plant biology. A) Systematic Botany; B) Physiology; C) Pathology; D) Anatomy; E) Morphology; F) Ecology; G) Mycology; H) Phycology; I) Cell Biology; J) Genetics; K) Evolution; K) Plant Utilization; M) Cell Physiology; N) Developmental Plant Biology; O) Cell and Tissue Culture; P) Physiological Ecology; Q) Plant Disease Control; R) Plant Hormones. Prereq: permission. 1–6 cr.

995. Investigations in Plant Biology
Supervised projects in selected areas of plant biology. A) Systematic Botany; B) Physiology; C) Pathology; D) Anatomy; E) Morphology; F) Ecology; G) Phycology; H) Mycology; I) Cell Biology; J) Cell Physiology; K) Microtechnique; L) Cell and Tissue Culture; M) Genetics; N) Crop Management; O) Developmental Plant Biology; P) Scientific Writing; Q) History of Botany; R) Teaching in Plant Biology. Prereq: permission. 1–6 cr.

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

899. Master's Thesis
6–10 cr.

999. Doctoral Research

Political Science (POLT)

Chairperson: Robert E. Craig
Professors: Bernard K. Gordon; David L. Larson; David W. Moore; George K. Romoser; B. Thomas Trout; Susan O. White
Associate Professors: Warren R. Brown; Robert E. Craig; John R. Kayser; Lawrence W. O'Connell; Clifford J. Wirth
Assistant Professors: Judith A. Gentleman; Aline M. Kuntz; Susan J. Siggelakis
Graduate Program Coordinator: Lawrence W. O'Connell

Degrees Offered

The Department of Political Science offers the master of arts in political science and the master of public administration. Areas of specialization for the master of arts are political thought, American politics, comparative politics, and international politics.

Admission Requirements

Applicants are expected to have majored either in political science or a closely related field. Where undergraduate preparation has been insufficient, applicants may be admitted provided that they follow without credit a program of study approved by the chairperson. The Graduate Record Examination general test is required for the M.A.; either the Graduate Record Examination general test or the Graduate Management Admission Test is required for the M.P.A.

M.A. Degree Requirements

This 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 four-credit internship program (POLT 970, Administrative Internship) for a total of 36 credits.

Of the eight courses, three are required core courses (POLT 905, POLT 906, POLT 907), two are elective courses in public administration and political science, and three may be selected from other departments in related fields, including administration, health management and policy, leisure management and tourism, resource economics, community development, and others.

Students who have had appropriate responsibility in public administration may be exempted from the internship upon petition for such exemption. Such students will be required to undertake independent research on an approved topic related to public administration (POLT 995 or 996, four credits).

A student may concentrate all three electives in one department or choose from separate departments. A student who concentrates three courses in leisure management and tourism may also take the internship under the direction of faculty in that department.

The program is offered for full- and part-time students. The full-time program can be completed during one academic year (four courses each semester) plus one summer (internship). The part-time program, designed for working professionals, can be completed during late afternoon or evenings.

American Politics and Public Administration

801. Courts and Public Policy
Impact of judicial decisions on public policy at federal, state, local, and regional levels. 4 cr.

802. Public Planning and Budgeting
Analysis, goal setting, and strategic planning in a governmental setting, with particular emphasis on budgetary processes as a means for controlling policy effectiveness. 4 cr.

803. Urban and Metropolitan Politics
Planning and management of the urban community, intergovernment relations, administrative functions, and general urban problems. 4 cr.

804. Policy and Program Evaluation
Policy and program evaluation of federal, state, and local governmental enterprise; focuses on the politics, practices, and methods of evaluative investigation. Evaluation as a technique for providing rational information for budgetary and policy-making decisions. 4 cr.

897, 898. Section B: Seminar in American Politics
Advanced analysis and individual research. 4 cr.

897, 898. Section F: Seminar in Public Administration
Advanced analysis and individual research, including opportunities for direct observation of governmental administration. 4 cr.

905. Methods of Policy Analysis
Research design, survey methods, experimental techniques, and aggregate data analysis applied to public policy settings. 4 cr.

906. Theories and Processes of Public Administration
Theories of organization and bureaucracy, the implications of bureaucratization, and the major processes of public administration including budgeting, personnel, policy making, as well as attention to contemporary policy issues including collective bargaining, affirmative action, citizen participation. 4 cr.

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

Political Thought

820. Perspectives on Political Science
Different views on the study and meaning of politics. Perspectives of political scientists, political philosophers, and political activists. 4 cr.

897, 898. Section I: Seminar in Political Thought
Advanced treatment and individual research. 4 cr.

Comparative Politics

843. Comparative Political Economy
Exploration of the origins, development, and functions of the modern state in the West, its links with markets and capitalism, and its role in contemporary political economy. Examples from various advanced industrial societies. 4 cr.

897, 898. Section C: Seminar in Comparative Politics
Advanced analysis and individual research on foreign nations or regions, focusing on governmental institutions, foreign policy, political parties, or bureaucracy. 4 cr.

International Politics

860. Theories of International Politics and Integration
General explanations of the behavior of nations; theory and practice of supra-national integration; theories of peace and security and community building at the international level;

concepts and experience in arms limitations and conflict resolution. 4 cr.

861. International Law
Formalized processes for regularizing state behavior; development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Arms reduction and limitation arrangements; inspection, and other formal procedures designed to preserve peace. 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 both to domestic as well as international political considerations. 4 cr.

878. International Organization
Collective security and other forms of cooperation among nations through international organizations such as the United Nations and its predecessors, and through regional bodies. 4 cr.

897, 898. Section E: Seminar in International Politics
Advanced analysis and individual research; emphasis on developments in theory. 4 cr.

General Courses

970. Administrative Internship
Practical administrative experience in an area of professional interest. Prereq: M.P.A. candidate. 4 cr.

995, 996. Reading and Research in Political Science
A) American Politics; B) Comparative Politics; C) International Politics; D) Political Thought; E) Public Administration; F) Public Policy. The graduate student will engage in independent study under the direction of one of the members of the department. Requires approval of the graduate committee. 1–4 cr.

899. Master's Thesis
Each student will carry out original research that culminates in a master's thesis. Must be taken 4 cr. per semester in each of two semesters, or 8 credits in one semester. 8 cr. required. Cr/F.

Psychology (PSYC)

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

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), and two semesters of the practicum and seminar in the teaching of psychology (PSYC 991-992). Work outside the department is also included in each student's program. Depth in a particular area is obtained through participation in advanced seminars and by independent reading and research conducted under the supervision of a faculty member. Since topics generally differ each time an advanced seminar is offered, advanced seminars may be repeated for credit.

Prior to the doctoral dissertation, the student carries out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree is awarded upon the successful completion of a program approved by the department and dean of the Graduate School. This typically takes place by the end of the second year.

The third year of the program is dedicated to the practicum and seminar on the teaching of psychology in conjunction with the teaching of introductory psychology.

Advancement to candidacy for the Ph.D. degree depends upon receiving the master's degree, the passing of a specialist examination in one of the department's areas of specialization, and identifying a topic for doctoral research. Advancement to candidacy is usually accomplished by the end of a student's third year in the program; the fourth year is generally devoted to dissertation research and to the teaching of an introductory course in the student's specialty area.

For more details about the graduate program, for application forms, and for a schedule of course offerings, contact the department. Approval of the instructor is required before registering for any graduate course.

810. Visual Perception
Anatomy, physiology, psychophysics, and perceptual processes of vision. Topics include physics of light, psychophysics, color, pattern and form, depth, motion, eye movements, visual learning and development, and constancy. 4 cr.

811. Sensation and Perception
Anatomy, physiology, psychophysics, and perceptual processes of the visual, auditory, gustatory, olfactory, and cutaneous senses. Topics include stimulus definition, psychophysics, sensory transduction, sensory and perceptual adaptation, and neural coding of space, time, magnitude, and quality. 4 cr.

812. Psychology of Language
Theories of language structure; functions of human language; meaning; relationship of language to other mental processes; language acquisition; indices of language development; speech perception; reading. 4 cr.

813. Cognition
Complex mental activities; consciousness and attention; concept formation; reasoning; problem solving; creative thinking; relationship between cognition and affective behavior. 4 cr.

821. The Experimental Analysis of Behavior
Environmental and biological determiners of behavior. Theory, research methods, and applications. Major concepts and recent research. 4 cr.

831. Brain and Behavior
Relationships between the nervous system and behavior. Physiological, neural, and biochemical mechanisms underlying instinct, memory, learning, emotion, and consciousness in humans; evolution of these functions in lower animals. 4 cr.

832. Comparative Psychology
Comparisons of the basic processes of sensation, motivation, learning, and social behavior in different species. Contemporary theories of behavior formulated by ethologists and ecologists contrasted and compared with current theories in psychology. 4 cr.

852. Advanced Social Psychology
Survey of current research and major theories; in-depth critical analysis of topics such as attribution theory, social cognition, and theories of aggression. 4 cr.

870. History of Psychology
History of psychology up to the 20th century. Major figures, theories, and developments. Relationship to developments in cultural history, philosophy, and the natural sciences. Beginnings of modern scientific psychology. 4 cr.

871. Psychology in 20th-Century Thought and Society
Reassesses, extends, and integrates knowledge of 20th-century psychology within the historical perspective. Major figures, schools, systems, theories. Social, institutional, and international developments since the 19th century. Review of major fields of psychology. 4 cr.

881. Advanced Child Development
Concepts, issues, theories, and methods in developmental psychology and their role in research. Content areas include cognitive, language, social, and personality development. 4 cr.

901-902. Graduate Proseminar
An intensive, two-semester, team-taught introduction to the specialty areas represented by the department. 8 cr.

905-906. Research Methodology and Statistics I-II
A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction, the theory underlying statistical inference, parametric and nonparametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Prereq: undergraduate statistics and experimental psychology. 4 cr.

907. Research Methods and Statistics III
The application of multivariate methods of data analysis in psychological research: multiple regression, analysis of covariance, Hotelling's T2 multivariate analysis of variance, path analysis, discriminant functions, canonical correlation, factor analysis. 4 cr.

908. Advanced Seminar in Quantitative and Analytic Methods
Advanced treatment of methodological topics of current interest. Content varies: representative topics include field research, surveys, time series, causal analyses, log-linear models, formal and mathematical models, and computer simulation. May be repeated for credit. 4 cr.

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

917. Advanced Seminar in Sensory and Perceptual Processes
Comprehensive examination of a specific topic in sensory and perceptual processes. May be repeated for credit. 4 cr.

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

945. Advanced Seminar in Learning and Behavior Analysis
Current empirical and theoretical issues in learning and the analysis of behavior. May be repeated for credit. 4 cr.

954. Advanced Seminar in Social Psychology
Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students participate directly in the conduct of the seminar by means of individual topical discussions, development and/or execution of research designs, and critical assessment of the current state of the topic area under discussion. Illustrative topics: political behavior, paralinguistics and nonverbal communication, ethnic and racial prejudice, and environmental psychology. May be repeated for credit. Prereq: PSYC 852. 4 cr.

962. Advanced Seminar in Abnormal Psychology
An in-depth examination of topics in abnormal, clinical, and counseling psychology. 4 cr.

973. Methods and Theories in Historical Research on the Behavioral Sciences
Major methods and theories used in historical research applied to the study of the behavioral sciences. Prereq: PSYC 870 or 871 or permission. 4 cr.

974. Advanced Seminar in the History and Theory of Psychology
In-depth examination of a specific topic in the history and/or theory of psychology. Topics vary each time the seminar is offered. Prereq: PSYC 870 or 871 or permission. May be repeated for credit. 4 cr.

982. Advanced Seminar in Developmental Psychology
In-depth analysis of one or several specific topics or issues in developmental psychology. May be repeated for credit. 4 cr.

991-992. Practicum and Seminar in the Teaching of Psychology
Practicum offers the student an opportunity to teach introductory psychology under close supervision from the staff. The seminar is coordinated with this experience and focuses on both practical and theoretical issues of significance in the teaching/learning process at the college level. 6 cr.

995. Reading and Research in Psychology
A) Cognition/Psycholinguistics; B) Developmental Psychology; C) History and Theory of Psychology; D) Learning and Behavior Analysis; E) Personality/Psychopathology; F) Physiological Psychology; G) Sensation/Perception; H) Social Psychology; I) Statistics/Methodology. As part of the development as an independent scholar, the student is encouraged to plan (1) broad reading in an area; (2) intensive investigation of a special problem; or (3) experimental testing of a particular question. Requires approval of both adviser and faculty member directing project. May be repeated for credit. 1–4 cr.

998. Problems and Issues in Psychology
Seminar on a problem that has been the subject of specialized research and study by a member of the faculty. Topic and instructor vary. May be repeated for credit. 4 cr.

894. Advanced Research in Psychology
Student designs and conducts original research that culminates in a paper of publishable quality. Completion of either this course or PSYC 899 satisfies the department's research requirement for the master's degree. May be taken for 4 cr. per semester in each of two semesters or 8 cr. in one semester. Maximum 8 cr. Cr/F.

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

999. Doctoral Research

Resource Administration and Management (RAM)

Professors: John E. Carroll; Owen B. Durgin; Edmund F. Jansen, Jr.; Betty Holroyd Roberts
Adjunct Professor: George Frick
Associate Professors: Robert T. Eckert; Theodore E. Howard; Bruce E. Lindsay; Douglas E. Morris; C. Tattersall Smith, Gus C. Zaso
Research Associate Professor: Jerry J. Vaske
Assistant Professors: Maureen Donnelly; John M. Halstead; Donald G. Hodges; Alberto B. Manalo
Graduate Program Coordinator: Edmund F. Jansen, Jr.

Degree Offered

The Department of Resource Economics and Community Development coordinates the interdisciplinary master of science de-

gree 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.

800. Planned Change in Nonmetropolitan Communities
Discussion and application of community development theory and principles using appropriate research methodologies. Areas of study chosen from population growth, community planning and development, provision and distribution of services, rural-urban differences and system management. Emphasis on empirical research studies. Students may participate in community-development activities. May include placement in field agency. Prereq: statistics or permission. 4 cr. (Offered in even-numbered years.)

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 yearlong 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 scientific, 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 identification of unifying concepts in the management of specific renewable resources, soils, water, forests, and wildlife. (Also offered as RECO 911.) Prereq: permission. 4 cr.

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: Owen B. Durgin; Edmund F. Jansen, Jr.
Associate Professors: Bruce E. Lindsay; Douglas E. Morris
Research Associate Professor: Jerry J. Vaske
Assistant Professors: John M. Halstead; Alberto B. Manalo
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.

Applicants with good undergraduate records who lack 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 upon 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; ECON 926, Econometrics I, or ECON 927, Econometrics II; RECO 808, Environmental Economics or RECO 856, Rural and Regional Development; RECO 815, Linear Programming and Quantitative Methods; 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; permission. 4 cr. (Offered every third semester.)

810. Resource Economics Seminar
Seminars arranged to students' needs and offered as demand warrants. A) Rural Development; B) Marine Economics; C) Community Economics; D) Land and Water Economics; E) Quantitative Methods; F) Recreation Economics; G) Small Business Economic and Managerial Issues. In-depth treatment of area, including classic works. May be repeated. 2–4 cr.

815. Linear Programming 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 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 yearlong 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.)

909. Agricultural Economics
Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision making in food production, marketing, and consumption; the competitive structure of the food industry. 4 cr. (Not offered every year.)

911. Natural and Environmental Resource Management
Fundamental scientific, aesthetic, and ethical principles involved in the management of renewable natural resources and ways to apply these principles in the formulation and evaluation of resource-management policies including the identification of unifying concepts in the management of specific renewable resources, soils, water, forests, and wildlife. (Also offered as RAM 911.) Prereq: permission. 4 cr. (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; Bud B. Khleif; Arnold S. Linsky; Stuart Palmer; Frederick Samuels; Murray A. Straus
Associate Professors: Peter Dodge; Lawrence C. Hamilton; Sally K. Ward
Assistant Professors: Lynn Chancer; Cynthia M. Duncan; Heather Turner
Graduate Program Coordinator: Lawrence C. Hamilton

Degrees Offered

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in sociology. The master's degree program emphasizes theory and methodology. Students in the doctoral program are expected to select from the areas of departmental specialization one major area—and from the areas of expertise found among the faculty, one minor area—for intensive study and examination. There are five major substantive areas for possible specialization: deviance, conflict, and control; social psychology; comparative institutional analysis; family; and social differentiation. Students may pursue specialties within or across the major areas of specialization or propose to the Graduate Committee other major areas of specialization that fall within the faculty's competence.

Admission Requirements

Applicants must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the general test, and the subject test in sociology.

Undergraduate majors in other fields may be admitted, in which case subject tests in their majors may be required. However, if the student's undergraduate work has not included an introductory course in sociological theory, research methods, statistics, and two other sociology courses, these five courses must be taken—or equivalent knowledge demonstrated through examination—in addition to the requirements outlined above.

All students entering the program must complete the M.A. before admission to the Ph.D. program. The department welcomes both applicants who plan to continue for the Ph.D. as well as students planning for the M.A. only.

M.A. Degree Requirements

Students must fulfill the following requirements:

1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level coursework in sociology including Sociological Methods I (901); and either 902, 903, or 904; and Sociological Theory I (911).
2) Register for one credit of thesis work during the second semester of residence and submit a draft of a proposal to the thesis committee by the end of the semester.
3) Submit for approval a report of a research endeavor to the thesis committee.

Students anticipating careers in applied sociology may receive academic credit for ongoing field experience under SOC 995, 996; an academic paper is required.

Ph.D. Degree Requirements

As part of fulfilling the residence requirement of three years' work after the bachelor's degree, students must

1) take a minimum of 12 courses in sociology (at least 8 as seminars), other than thesis or dissertation research, including Sociological Theory I and II (911 and 912),

Sociological Methods I and II (901 and 902), and one other course in methods or statistics (903 or 904), three courses in a major area, and two in a minor area of sociology;
2) complete a second minor consisting of three related courses whether or not sociological in content (these three courses are in addition to the twelve required courses in sociology); no preliminary examination is required;
3) pass written examinations in the major and minor areas of sociological specialization and in advanced theory and methodology;
4) demonstrate reading-level proficiency in a foreign language or a research tool appropriate to the overall program of the student. (The research tool option must not be part of the other degree requirement for graduate students in sociology; examples of appropriate research tools include computer programming, symbolic logic, historiography, econometric techniques, and mathematical statistics. At the time they are admitted to the Ph.D. program, students must submit, for approval by the Graduate Committee, a statement indicating how they intend to meet the language/research tool requirement);
5) fulfill the research and/or teaching requirement described below;
6) write and defend an acceptable doctoral dissertation.

Teaching Requirement

An important part of the graduate program is the opportunity to learn from participation in the teaching and research activities of the department faculty. All doctoral students are therefore expected to assist a member of the department in teaching and/or research.

820. Current Developments in Sociology of the Family
A current topic is selected each semester, such as stratification and the family, intrafamily communication, power structure of the family, kinship in modern societies. Critical review of the literature; class or individual research project usually will be carried out. Prereq: 8 credits of sociology; a family course recommended. 4 cr.

821. Family Interaction
Analysis of family interaction from a sociological perspective. Consideration of individual family members, relationships, and the family as a unit using a social systems approach. Prereq: intro. soc. or permission. 4 cr.

835. Complex Organizations
Comparative study of the structure and dynamics of complex, formal organizations (business, military, political, and governmental, educational, medical). Power and social control in formal systems; organizational processes, performances, and effectiveness; effect of complex, formal organizations on persons and societies. Prereq: permission. 4 cr.

840. Culture Change
Various types of society; development of theory. Descriptive studies of institutional as well as theoretical materials selected from the writings of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. 4 cr.

841. Social Change and Societal Development
Comparative, interdisciplinary approach. Interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prereq: permission. SOC 840 recommended. 4 cr.

850. The Middle East: Issues of Ethnicity, Work, and Identity
Community studies approach to such topics as ethnicity and identity in the interrelationship of language, religion, and corporate membership in a community; ethnic division of labor; work, pluralism, and family networks; mobility and immobility; estates vs. classes. 4 cr.

857. Social Institutions of Latin America and the Caribbean
Selective analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prereq: permission. 4 cr.

861. Population Dynamics
Major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development.Interrelationship of population and society. 4 cr.

870. Culture, Personality, and Society
A cross-cultural view of the development of personality as emergent from genetic, situational, and sociocultural determinants; analysis of the dynamic interplay of sociocultural and psychological behavior systems. Prereq: prior courses in sociology, anthropology, or psychology. 4 cr.

880. Social Conflict
Nature of social conflict, especially war. Setting and initiation of conflict, its dynamics, and factors affecting its course and outcomes. Prereq: permission. 4 cr.

885. The Study of Work
Understanding society through the structure of work. Case studies, in an ethnographic manner, of high-status and low-status occupations to provide understanding of social processes and interrelationships in the social structure. 4 cr.

890. Applied Sociology
1) Current level of use of sociological knowledge; 2) the advocate, consultant, and researcher roles in applied settings; 3) techniques of applied research; 4) implications of applied sociology, including ethical problems. Each student focuses on a social problem and writes a paper covering the above issues. Applied projects where possible. Prereq: meth. of soc. res. 4 cr.

894. Evaluation of Social Programs
Evaluation research defined: purposes of evaluation; design of evaluation studies; setting of programs; utilization of evaluation results. Examination of case studies of evaluations of social programs. Students are responsible for designing an evaluation study in their chosen substantive area. Prereq: meth. of soc. res. 4 cr.

897. Special Topics in Sociology
Occasional or experimental offerings. Prereq: permission. May be repeated for different topics. 4 cr.

901. Sociology Methods I: Intermediate Social Statistics
Application of statistical methods to the analysis of social data, with particular emphasis on multiple regression and related topics. 4 cr.

902. Sociological Methods II: Research Design
Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses are pursued. Prereq: meth. of soc. res.; soc. stat.;/or their equivalents or permission. 4 cr.

903. Sociological Methods III: Special Problems in Methods and Statistics
Course alternates among special problems, such as measurement and advanced statistics. 4 cr.

904. Sociological Methods IV: Field Work
Training for participant observation in the manner of an anthropologist or Chicago-school sociologist. Students write and discuss field notes and become familiar with case studies, content analysis, and relevant issues. Field notes, basis for a term paper. 4 cr.

911. Sociological Theory I
The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prereq: hist. of soc. theory; contemp. soc. theory;/or their equivalents. 4 cr.

912. Sociological Theory II
The content, presuppositions, and implications of contemporary sociological theory. Students engage in theory construction and analysis and in this endeavor are encouraged to develop their particular interests in substantive areas. Prereq: SOC 911. 4 cr.

913. Sociological Theory III
A seminar of intensive study of topics in sociological theory. Sample topics include exchange theory, functionalism, systems theory, theory construction, pioneering theorists. Prereq: hist. of soc. theory; contemp. soc. theory;/or their equivalents. 4 cr.

921. Deviant Behavior
Relationships among cultural, subcultural, and

personality variables and deviant behavior; forms of deviant behavior: invention, crime, alcoholism, and emotional illness. Prereq: permission. 4 cr.

930. The Small Group
Sociological and social psychological perspectives on interaction within small groups. Prereq: courses in sociology and social psychology, or permission. 4 cr. (Not offered every year.)

934. Sociology of Mental Health and Illness
This seminar reviews major sociological theories of mental illness including social isolation, labeling, stressful life events, role conflicts, social class, and economic factors and family dynamics. Family and community processes involved in becoming a mental patient and the problems of leaving the role of the mentally ill are examined. The politics of mental illness are considered, including decarceration, issues surrounding sex roles and mental illness, patients' rights, and the prediction of dangerousness. Other topics covered include cross-cultural comparisons in diagnosis and treatment, training of clinicians, and mental health as a social movement. 4 cr.

938. Sociology of Education: Social Organization of Schools and Community
Schools in their sociocultural contexts and as part of the institutional network of society. Relation to stratification and social control. Teaching as a religious occupation and as an emergent profession. 4 cr.

942. Sociology and Social Policy
Social policy and public policy defined: description of the policy-making process. The political sociology of the policy-making process; who makes policy and who influences policy, under what conditions, and with what effect. Definition of social policy research and the various roles social scientists can adopt for policy-relevant work. Students are responsible for critiquing the readings and for preparing a substantial research paper. 4 cr.

950. Methods of Social Psychological Analysis
The logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Experimental and nonexperimental designs, the social-psychological aspects of laboratory and field research, the nature of artifacts, etc. Emphasis is on research design rather than statistical analysis, but graduate-level sophistication in statistics is assumed. 4 cr.

951. Seminar in Social Psychology
Some of the major themes in social-psychological theory, including social structure and personality, socialization, small-group processes, and interaction analysis. Students are expected to read and evaluate selected empirical research. 4 cr.

954. Sociology of Religion
The reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change; and the problem of church and state. 4 cr.

961. Demography
Current problem areas in demography including population theory, formal demography, social epidemiology, social indicators, use of demographic sources and techniques in sociological investigation. Prereq: SOC 861 or permission. 4 cr.

970. Comparative Institutional Analysis
Theory and methods of cross-national approaches, including history, variations in objectives and methods, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prereq: permission. 4 cr.

975. Sociology of the Family
Major approaches in the sociological study of families. Individuals in families, family relationships, and families as groups, and the interrelationships among these levels. Interactional and systemic properties of marriage, parent-child relations, and extended family relations. 4 cr.

976. Violence in the Family
Analysis of abusive relationships within the family, especially physical and sexual abuse of children and spouses. The primary focus is on the design of research to test theories purporting to explain intra-family violence, consequences of violence for family members and society, and research on prevention. 4 cr.

980. Social Differentiation
Seminar allowing intensive examination of selected topics in differentiation and personnel allocation, with sections rotated among faculty members, in (1) social stratification, (2) race and ethnic relations, and (3) age and sex. Prereq: social stratification and either race and ethnic relations or female, male, and society. 4 cr.

985. Occupations and Professions
Professionalization as adult socialization, an acquisition of a new identity. Professions as ideologies, markets, and extended families. Research perspective of the Chicago School of Sociology. 4 cr.

989. Sociology of Education: Race and Ethnic Relations in Schools and Society
Ethnic stratification inside and outside the school. The schooling of whites and nonwhites. Issues of bilingualism, culture, and identity. 4 cr.

995, 996. Reading and Research in Sociology and Anthropology
A) Communications; B) Criminology; C) Cultural/Social Anthropology; D) Culture Change; E) Culture and Personality; F) Deviant Behavior; G) Prehistoric Archaeology; H) Family; I) Population; J) Rural-Urban; K) Social Control; L) Social Differentiation; M) Social Movements; N) Social Psychology; O) Social Research; P) Social Theory; Q) Anthropological Linguistics; R) Social Welfare. A student prepared by training and experience to do independent work under the guidance of an instructor may register for one or more of these sections. Prereq: 16 graduate hours of sociology and permission. Hours and credit to be arranged. 1–4 cr.

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

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

999. Doctoral Research

Soil Science (SOIL)

(See Department of Natural Resources.)

Spanish (SPAN)

Chairperson: Barbara H. Wing
Professors: Richard J. Callan; Charles H. Leighton
Associate Professors: F. William Forbes; Bernadette Komonchak; Barbara H. Wing
Assistant Professors: John M. Chaston; William Mejias-Lopez; Phoebe A. Porter; 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 901. Teaching assistants must also take 903. No student may register for a graduate course if he or she has already taken the corresponding undergraduate course here or its equivalent elsewhere.

A comprehensive examination based on a master's degree reading list is given four times a year. 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.

852. Drama and Poetry of the Siglo de Oro
Social and historical background of Baroque period. Representative plays of Lope de Vega, Tirso de Molina, Calderón; lyric poetry of Lope, Góngora, and Quevedo; prose developments. 3 cr. (Not offered every year.)

854. Cervantes
Cervantes's literary art. Selections from the major works. The Quijote, its originality and significance; its antecedents; its religious, philosophical, and sociological aspects; and its artistic structure. 3 cr. (Not offered every year.)

855. Literature of the 19th Century
Larra, Espronceda, Bécquer, Pérez Galdós, and Blasco Ibáñez. Romanticism, realism, and naturalism. 3 cr. (Not offered every year.)

857. Theater and Poetry of the 20th Century
The Generation of 1898 and Modernismo: Lorca, Casona, Buero Vallejo, Sastre, Salinas, Guillén, and Miguel Hernández. 3 cr. (Not offered every year.)

858. Spanish Prose of the 20th Century
Novels, short stories, and essays. Unamuno, Baroja, Menéndez Pidal, Ortega y Gasset, Julián Marías, Aranguren, Pérez de Ayala, Gironella, and Cela; survey of contemporary prose. 3 cr. (Not offered every year.)

860. Unamuno and Ortega y Gasset
Philosophical ideology and literary content of major contributions of Miguel de Unamuno and 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 to grammatical contrasts between Spanish and English. 3 cr.

891. Methods of Foreign Language Teaching —Spanish
Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary grades through college. Discussion, demonstration, preparation of instructional materials, microteaching of the language skills. Prereq: permission. 3 cr.

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; I) 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; M) Contemporary Latin American Literature; N) Structural and Applied Linguistics; O) Spanish Literary Criticism; P) Latin American Essay; Q) Latin America; S) Spanish Theatre; T) Spanish Poetry; U) Latin American Poetry; V) Galdos; W) Archetype Latin American Literature; X) Special Teaching Problems; Y) 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 States; B) Portuguese; C)Hispanic Film; D) Introduction to Hispanic Linguistics; F) Other. Specialized courses covering topics not normally presented in regular course offerings. Barring duplication of content, Topic F may be repeated for credit. Prereq: permission of major supervisor. 3 cr.

901. Bibliography and Methods of Research
Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques and to form and style in the preparation and writing of research findings. Preparation of a research paper. 1 cr.

903. Applied Linguistics
Required of all graduate assistants teaching in the departmental program, but open to all graduate students in Spanish. Discussion of current methodology and linguistic approaches to the teaching of Spanish. Instruction in the use of audio-visual aids including language laboratories. Readings, discussion, class observation. May be repeated for a total of 3 cr. 1 cr.

925. Advanced Spanish Civilization and Culture
Selective study of social, artistic, historical, and cultural aspects in the life and work of the people in present-day Spain through readings in contemporary literature and journals. 3 cr. (Offered in alternate years.)

926. Advanced Latin American Civilization and Culture
Indigenous peoples. Conquest period. Then a study of the European and Indian substrata that form the present-day Latin Americans. Modern and colonial architecture. Modern painting. 3 cr. (Offered alternate years.)

997. Graduate Seminar
Presents and discusses selected topics in Spanish language and literature. See SPAN 897 for list of topics. Prereq: permission of major supervisor. 3 cr.

998. Graduate Seminar
Presents and discusses selected topics in Spanish language and literature. See SPAN 898 for list of topics. Barring duplication of content, Topic F may be repeated for credit. Prereq: permission of major supervisor. 3 cr.

899. Master's Thesis
6 cr.

Wildlife (WILD)

(See Department of Natural Resources.)

Zoology (ZOOL)

Chairperson: Peter F. Sale
Professors: Arthur C. Borror; James F. Haney; Larry G. Harris; Peter F. Sale; John J. Sasner, Jr.; Edward K. Tillinghast; Charles W. Walker
Adjunct Professors: Miyoshi Ikawa; Philip J. Sawyer
Associate Professors: John E. Foret; W. Huntting Howell; Stacia A. Sower; James T. Taylor; Winsor H. Watson III
Assistant Professors: Thomas D. Kocher; Richard R. Olson; Michelle P. Scott
Adjunct Assistant Professors: David T. Bernstein; 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 in-

cluding general biology, development, general ecology, genetics, morphology, and physiology is normally required. Additionally, organic chemistry and a semester each of calculus and physics are necessary. Applicants who are deficient in any of these requirements may be admitted to graduate status but may be required to remedy their deficiencies by taking courses that do not give graduate credit. Applicants must submit general and subject biology scores for the Graduate Record Examination.

M.S. Degree Requirements

Students plan a program of study in conjunction with a faculty advisory committee. Students complete a thesis of no more than 10 credits that is acceptable to the guidance committee. Prior to the receipt of the master's degree, all candidates must pass a 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 system on the physiology of vertebrates, with special reference to mammals. Current investigations of the endocrine system as a regulator and integrator of body functions including such systems as growth, reproduction, metabolism, differentiation, and behavior. Prereq: principles of biology. 4 cr.

806. Evolutionary Mechanisms
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.

808. Stream Ecology
Ecological relationships of organisms in flowing water. Lectures on physical and chemical features of streams, floral and faunal communities, and factors controlling populations of benthic invertebrates. Streams as ecosystems. Laboratory exercises employ both field and laboratory experimental techniques. Occasional Saturday field trips. Weekly seminars on original research papers. 4 cr. (Not offered every year.)

809. Environmental Physiology of Animals
Animals' responses to natural changes or extremes of the physical environment. 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 spacial distribution; trophic interactions of communities, role in nutrient cycle of lakes. Experimental techniques employed in field trips to freshwater habitats. Seminars examine current research. Prereq: gen. ecol. and limnology, ZOOL/PBIO 817, or equivalent; permission. 4 cr. (Not offered every year.)

812. Mammalogy
Origins, diversification, reproduction, ecology, behavior of mammals. Identification of local forms. Prereq: prin. of biol. or equivalent. Lab. 4 cr.

813. Animal Behavior
Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prereq: prin. of biol. I and II or equivalent. Lab. 4 cr. (Not offered every year.)

816. Quantitative Ecological Analysis
Methods of observation and inference in ecology; data reduction and exploratory analysis; detection of association, difference, and similarity using linear models and other multivariate approaches. Critiques of design and analysis of published studies. Prereq: formal coursework in statistics and ecology; permission. 4 cr.

817. General Limnology
Special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prereq: gen. ecol.;/or equivalent. (Also offered as PBIO 817.) 4 cr.

819. Field Limnology
Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods used to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: general limnology or equivalent; permission. (Also offered as PBIO 819.) Lab. 4 cr.

823. Molecular Biology of the Eukaryotic Cell
Examination of dynamic interrelationships between cellular structure and function at the molecular level. Viral, prokaryotic, and eukaryotic models used to illustrate molecular regulatory mechanisms underlying biological complexity. Recent advancements presented against a background of fundamental concepts. Emphasis on normal and impaired cellular differentiation, growth, interphase function, and proliferation. Also considered are the coupling of energy to cellular processes, the role of bioelectricity, and intrinsic and extrinsic chemical messengers. Prereq: organic chemistry (organic chem. or equivalent). Recommended: developmental or cell biology (devel. biol. of the vertebrates or invertebrates); biochemistry or physiology (prin. of animal phisiol. 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. Immunochemical techniques, traditional and innovative applications of electron and light microscopy, bioassay, cell culture and fractionation, and electrophysiology. Coreq: ZOOL 823. Special fee. 2 cr.

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.)

828. Developmental Biology of the Invertebrates
Principles of animal development including a modern discussion of the cellular processing of developmental information and a panoramic view of reproduction and development in the

invertebrates. Prereq: prin. of biol. or intro to invert. zool. Lab. 4 cr.

850. Biological Oceanography
Biological processes of the oceans including primary and secondary production, trophodynamics, plankton diversity, zooplankton feeding ecology, microbial ecology, and global ocean dynamics. Emphasis on experimental approaches. Term project involves either development of an ecosystem model or performance of a field experiment. Field trips on *R.V. Jere Chase* and to the Jackson Estuarine Laboratory. Prereq: one year of biol. or permission of instructor. 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 seminar. May include reading, laboratory work, organized seminars, and conferences. Prereq: permission of department chairperson and staff concerned. 1–4 cr.

901. Research Methods in Zoology
Introduction to the range of research approaches in zoology, to the skills needed for success in graduate school and beyond. Topics 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.)

925. Concepts and Techniques in Reproductive Biology
Investigations of the reproductive biology of invertebrate and vertebrate organisms, including gonad and gamete structure and function; generation, maintenance, and modulation of gametogenesis by environmental and hormonal factors; larval settlement and metamorphosis; and evolutionary significance and functional consequences of reproductive cycles in animals. Prereq: permission. 4 cr.

926. Comparative Physiology
Nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: ZOOL 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

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Newington, N.H. (1988–1992)

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Durham, N.H. (1990–1994)

William F. Kidder, B.S.
New London, N.H. (1984–1992)

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Chancellor, University System
Durham, N.H. (ex officio)

Jean T. White, B.A.
Rindge, N.H. (1988–1992)

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Joseph F. Phelan, M.A.
Vice President for Alumni and University Relations

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

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Dean of the Graduate School

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 tthe Whittemore School of Business and Economics

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

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

Lewis Roberts, Jr., Ed.D.
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.

Faculty of the Graduate School

Faculty

(This listing is current as of July 1, 1991. The date of appointment appears in parentheses following the faculty member's name.)

Aber, John D. (1987)
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.
Amsden, Katherine (1967)
Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.
Andersen, Kenneth K. (1960)
Professor of Chemistry; Ph.D., University of Minnesota, 1959.
Anderson, Franz E. (1967)
Professor of Geology; Ph.D., University of Washington, 1967.
Andrew, Michael D. (1966)
Professor of Education; Ed.D., Harvard University, 1969.
Annis, William H. (1962)
Professor of Occupational Education; Ed.D., Cornell University, 1961.
Arnoldy, Roger L. (1967)
Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Minnesota, 1962.
Ashley, Charles H. (1969)
Associate Professor of Education; Ed.D., Boston University, 1969.
Baber, Kristine M. (1984)
Associate Professor of Family and Consumer Studies; Ph.D., University of Connecticut, 1983.
Bailey, Brigitte Gabcke (1987)
Assistant Professor of English; Ph.D., Harvard University, 1985.
Baker, Alan L. (1972)
Associate Professor of Plant Biology; Ph.D., University of Minnesota, 1973.
Baldwin, Kenneth C. (1982)
Associate Professor of Mechanical Engineering and Ocean Engineering; Ph.D., University of Rhode Island, 1982.
Ballestero, Thomas P. (1983)
Associate Professor of Civil Engineering; Ph.D., Colorado State University, 1981.
Balling, L. Christian (1967)
Professor of Physics; Ph.D., Harvard University, 1965.
Barkey, Dale P. (1987)
Assistant Professor of Chemical Engineering; Ph.D., University of California at Berkeley, 1987.
Barnett, John H. (1983)
Associate Professor of Business Administration; D.B.A., University of Colorado at Boulder, 1978.
Barrett, James P. (1962)
Professor of Forest Biometrics and Management; Ph.D., Duke University, 1962.
Barton, Richard (1991)
Assistant Professor of Education; Ph.D., University of Georgia, 1991.
Bauer, Christopher F. (1981)
Associate Professor of Chemistry; Ph.D., Colorado State University, 1979.
Baum, William M. (1977)
Professor of Psychology; Ph.D., Harvard University, 1966.
Bechtell, Homer F., Jr. (1966)
Professor of Mathematics; Ph.D., University of Wisconsin at Madison, 1963.
Bedker, Patricia Dugan (1985)
Assistant Professor of Animal Science and Occupational Education; Ph.D., Cornell University, 1985.
Benassi, Victor A. (1982)
Associate Professor of Psychology; Ph.D., City University of New York, 1974.
Bennett, Albert B., Jr. (1967)
Professor of Mathematics; Ed.D., University of Michigan at Ann Arbor, 1966.
Benoit, Jean (1983)
Associate Professor of Civil Engineering; Ph.D., Stanford University, 1983.
Bergeron, R. Daniel (1974)
Professor of Computer Science; Ph.D., Brown University, 1973.
Berndtson, William E. (1979)
Professor of Animal Science; Ph.D., Cornell University, 1971.
Bernstein, David T. (1989)
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Birch, Francis S. (1972)
Professor of Earth Sciences; Ph.D., Princeton University, 1969.
Blakemore, Richard P. (1977)
Professor of Microbiology; Ph.D., University of Massachusetts at Amherst, 1975.
Blanchard, Robert O. (1972)
Associate Dean of the College of Life Sciences and Agriculture and Professor of Plant Pathology; Ph.D., University of Georgia at Athens, 1971.
Bobick, Melvin T. (1958)
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Boccialetti, Gene (1983)
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Bogle, A. Linn (1970)
Professor of Botany; Ph.D., University of Minnesota, 1968.
Bonnice, William E. (1962)
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Bornstein, Steven P. (1989)
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Borror, Arthur C. (1961)
Professor of Zoology; Ph.D., Florida State University, 1961.
Bothner, Wallace A. (1967)
Professor of Geology; Ph.D., University of Wyoming, 1967.
Boudette, Eugene L. (1985)
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Boulton, Elizabeth P. (1988)
Assistant Professor of Animal Science; D.V.M., University of Georgia at Athens, 1980.
Bowden, William B. (1987)
Assistant Professor of Water Resources Management; Ph.D., North Carolina State University, 1982.
Bowman, James S. (1971)
Professor of Entomology and Extension Entomologist; Ph.D., University of Wisconsin at Madison, 1958.
Boy, Angelo V. (1965)
Professor of Education; Ed.D., Boston University, 1960.
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; Ph.D., Claremont Graduate School and University Center, 1976.
Brown, Wendell S. (1974)
Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., Massachusetts Institute of Technology, 1971.
Burger, John F. (1977)
Associate Professor of Entomology; Ph.D., University of Arizona, 1971.
Burton, David M. (1959)
Professor of Mathematics; Ph.D., University of Rochester, 1961.
Calarco, John R. (1981)
Professor of Physics; Ph.D., University of Illinois at Urbana, 1969.
Calculator, Stephen N. (1983)
Associate Professor of Communication Disorders; Ph.D., University of Wisconsin at Madison, 1980.
Callan, Richard J. (1969)
Professor of Spanish; Ph.D., St. Louis University, 1965.
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; Ph.D., Harvard University, 1966.
Carr, Russell T. (1984)
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 Joel (1987)
Assistant Professor of Electrical Engineering; Ph.D., University of Michigan at Ann Arbor, 1984.
Celikkol, Barbaros (1969)
Associate Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1972.
Chamberlin, Kent A. (1985)
Associate Professor of Electrical Engineering; Ph.D., Ohio University, 1982.
Chancer, Lynn (1991)
Assistant Professor of Sociology; Ph.D., City University of New York, 1988.
Chandler, Donald S. (1981)
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Charos, Evangelos (1988)
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Chasteen, N. Dennis (1972)
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Chaston, John M. (1989)
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Chesbro, William R. (1959)
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Chupp, Edward L. (1962)
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Cioffi, Grant L. (1980)
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Clark, Charles E. (1967)
Professor of History; Ph.D., Brown University, 1966.
Clark, Mary Morris (1978)
Professor of English; Ph.D., University of Massachusetts at Amherst, 1978.
Clark, Ronald R. (1957)
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Clarke, Eric O. (1991)
Assistant Professor of English; Ph.D., Brown University, 1991.
Cohn, Ellen S. (1978)
Associate Professor of Psychology; Ph.D., Temple University, 1978.
Collins, John J. (1988)
Assistant Professor of Biochemistry and Genetics; Ph.D., University of Wisconsin at Madison, 1984.
Collins, Michael R. (1985)
Associate Professor of Civil Engineering; Ph.D., University of Arizona, 1985.
Condon, William A. (1976)
Professor of Animal Science; Ph.D., University of Massachusetts at Amherst, 1975.
Connors, Robert J. (1984)
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Conway, Karen Smith (1987)
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Copeland, Arthur H., Jr. (1968)
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Corcoran, Ellen P. (1972)
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Corell, Robert W. (1957-60, 1964)
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Cote, Richard H. (1988)
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Craig, Robert E. (1966)
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Crill, Patrick M. (1988)
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Croce, Ronald C. (1986)
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Croker, Robert A. (1966)
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Crow, Garrett E. (1975)
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Curran-Celentano, Joanne (1982)
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Darlington, Sidney W. (1971)
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Davis, Thomas (1984)
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Dawson, John F. (1968)
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de la Torre, Pilar (1989)
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Demitchell, Todd A. (1990)
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Denis, Clyde L. (1982)
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DePorte, Michael V. (1972)
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DeTurk, Mark S. (1988)
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Diefendorf, Jeffry M. (1976)
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Diller, Ann L. (1973)
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Diller, Karl C. (1972)
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Dingman, S. Lawrence (1975)
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Dodge, Peter (1964)
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Dolan, Elizabeth M. (1980)
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Donnelly, Maureen (1989)
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Drake, Allen D. (1983)
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Ellis, Nancy E. (1987)
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Ellis, Walter L. (1989)
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Elmslie, Bruce T. (1989)
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Engalichev, Nicolas (1963)
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England, Richard W. (1976)
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Erickson, Raymond L. (1963)
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Eshbach, Robert W. (1987)
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Estes, George O. (1969)
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Etebari, Ahmad (1980)
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Evans, Christine V. (1987)
Assistant Professor of Pedology; Ph.D., University of Wyoming, 1987.
Fagerberg, Wayne R. (1984)
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Fairchild, Thomas P. (1969)
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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)
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Farrell, Marie P. (1990)
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Federer, C. Anthony (1970)
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Feintuch, Burt H. (1988)
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Feldman, David V. (1987)
Assistant Professor of Mathematics; Ph.D., Wesleyan University, 1987.
Ferber, Michael K. (1987)
Associate Professor of English; Ph.D., Harvard University, 1975.
Fernald, Peter S. (1966)
Professor of Psychology; Ph.D., Purdue University, 1963.
Ferrini-Mundy, Joan (1983)
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Fink, Stephen L. (1969)
Professor of Organizational Behavior; Ph.D., Case Western Reserve University, 1959.
Fisher, G. Thomas (1969)
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Fisher, Lester A. (1968)
Professor of English; Ph.D., Brown University, 1976.
Fisk, Lennard A., Jr. (1977)
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Forbes, F. William (1970)
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Forbes, Terry (1987)
Research Professor of Physics and Earth, Oceans, and Space; Ph.D., University of Colorado at Boulder, 1978.
Foret, John E. (1967)
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Forrest, David J. (1984)
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Foxall, Thomas L. (1984)
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Frankel, Barbara R. (1988)
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Franzosa, Susan D. (1979)
Associate Professor of Education; Ph.D., State University of New York at Buffalo, 1979.
Freear, John (1983)
Professor of Accounting and Finance; M.A., University of Kent, England, 1969. F.C.A.
Freuder, Eugene C. (1977)
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Frick, George (1955)
Adjunct Professor of Resource Economics; M.S., University of Connecticut, 1947.
Frierson, Cathy Anne (1991)
Assistant Professor of History; Ph.D., Harvard University, 1985.
Frost, Albert D. (1957)
Professor of Electrical Engineering; Sc.D., Massachusetts Institute of Technology, 1952.
Fuld, Kenneth (1979)
Associate Professor of Psychology; Ph.D., Dartmouth College, 1976.
Fussell, Barry K. (1987)
Assistant Professor of Mechanical Engineering; Ph.D., Ohio State University, 1987.
Garland, Virginia E. (1988)
Assistant Professor of Education; Ph.D., University of Connecticut, 1981.
Garrett, Peter W. (1970)
Adjunct Assistant Professor of Forest Genetics; Ph.D., University of Michigan at Ann Arbor, 1969.
Gass, Michael A. (1981)
Associate Professor of Physical Education; Ph.D., University of Colorado at Boulder, 1986.
Gaudard, Marie A. (1977)
Associate Professor of Mathematics; Ph.D., University of Massachusetts at Amherst, 1977.
Gaudette, Henri E. (1965)
Professor of Geology and Earth, Oceans, and Space; Ph.D., University of Illinois at Urbana, 1963.
Geeslin, William E. (1972)
Associate Professor of Mathematics; Ph.D., Stanford University, 1973.
Gentleman, Judith A. (1988)
Assistant Professor of Political Science; Ph.D., State University of New York at Buffalo, 1982.
Gerhard, Glen C. (1967)
Professor of Electrical Engineering; Ph.D., Ohio State University, 1963.
Givan, Curtis V. (1990)
Professor of Plant Biology; Ph.D., Harvard University, 1968.
Glanz, Filson H. (1965)
Professor of Electrical Engineering; Ph.D., Stanford University, 1965.
Golinski, Jan V. (1990)
Assistant Professor of History; Ph.D., The University of Leeds, 1983.
Goodman, Richard H. (1976)
Adjunct Associate Professor of Education; Ed.D., Harvard University, 1961.
Goodridge, Lyndon E. (1990)
Dean of the Whittemore School of Business and Economics and Professor of Business Administration; Ph.D., Purdue University, 1971.
Goodspeed, Charles H. (1978)
Associate Professor of Civil Engineering; Ph.D., University of Cincinnati, 1972.
Gordon, Bernard K. (1971)
Professor of Political Science; Ph.D., University of Chicago, 1959.
Gorsky, Robin (1984)
Associate Professor of Health Management and Policy; Ph.D., University of California at Berkeley, 1980.
Gow, Anthony Jack (1985)
Adjunct Professor of Glaciology; Ph.D., Victoria University of Wellington, New Zealand, 1973.
Graham, Karen J. (1987)
Assistant Professor of Mathematics; Ph.D., University of New Hampshire, 1986.
Graulich, Melody G. (1978)
Associate Professor of English; Ph.D., University of Virginia, 1979.
Graves, Donald H. (1973)
Professor of Education; Ed.D., State University of New York at Buffalo, 1973.
Green, Donald M. (1967)
Professor of Biochemistry and Genetics; Ph.D., University of Rochester, 1958.
Greenlaw, Raymond (1989)
Assistant Professor of Computer Science; Ph.D., University of Washington, 1988.
Gress, David L. (1974)
Associate Professor of Civil Engineering; Ph.D., Purdue University, 1976.
Gross, Charles W. (1986)
Professor of Marketing; D.B.A., University of Colorado at Boulder, 1972.
Gross, Todd Stuart (1988)
Associate Professor of Mechanical Engineering; Ph.D., Northwestern University, 1981.
Guare, Richard (1988)
Adjunct Assistant Professor of Communication Disorders; Ph.D., University of Virginia, 1982.
Gust, David A. (1985)
Adjunct Associate Professor of Geology; Ph.D., Australian National University, 1982.
Gutman, Jonathan (1987)
Professor of Business Administration; Ph.D., University of Southern California, 1967.
Hadwin, Donald W. (1977)
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Hageman, Elizabeth H. (1971)
Professor of English; Ph.D., University of North Carolina at Chapel Hill, 1971.
Hagstrom, Earl C. (1965)
Associate Professor of Psychology; Ph.D., Brown University, 1957.
Hall, Francine S. (1980)
Associate Professor of Organizational Behavior; Ph.D., University of Toronto, 1975.
Halstead, John M. (1988)
Assistant Professor of Resource Economics; Ph.D., Virginia Polytechnic Institute and State University, 1988.
Hamilton, Lawrence C. (1977)
Associate Professor of Sociology; Ph.D., University of Colorado at Boulder, 1978.
Haney, James F. (1972)
Professor of Zoology; Ph.D., University of Toronto, 1970.
Hanrahan, Linda (1988)
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Hansen, Jane A. (1979)
Associate Professor of Education; Ph.D., University of Minnesota, 1979.
Hansen, Larry J. (1973)
Associate Professor of Family and Consumer Studies; Ph.D., Florida State University, 1973.
Hansen, Nancy (1989)
Assistant Professor of Marketing; Ph.D., The Union Institute, 1989.
Hapgood, Robert (1965)
Professor of English; Ph.D., University of California at Berkeley, 1955.
Hardy, Stephen H. (1988)
Associate Professor of Physical Education; Ph.D., University of Massachusetts at Amherst, 1980.
Harkless, Gene E. (1985)
Assistant Professor of Nursing; D.N.Sc., Boston University, 1991.
Harrigan, Jane T. (1985)
Associate Professor of English; M.A., Syracuse University, 1976.
Harris, J. William, Jr. (1985)
Associate Professor of History; Ph.D., Johns Hopkins University, 1982.

Harris, Larry G. (1969)
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Harriss, Robert C. (1988)
Professor of Earth Sciences and Earth, Oceans, and Space; Ph.D., Rice University, 1965.
Harter, Robert D. (1969)
Professor of Soil Chemistry; Ph.D., Purdue University, 1966.
Hatcher, Philip John (1986)
Assistant Professor of Computer Science; Ph.D., Illinois Institute of Technology, 1985.
Hebert, David J. (1967)
Professor of Education; Ph.D., Kent State University, 1967.
Heisenberg, Jochen (1978)
Professor of Physics; Doctor, University of Hamburg, Germany, 1966.
Henry, Robert M. (1980)
Associate Professor of Civil Engineering; Ph.D., University of Pennsylvania, 1980.
Herold, Marc W. (1975)
Associate Professor of Economics; Ph.D., University of California at Berkeley, 1979.
Hersman, F. William (1984)
Associate Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1982.
Hertz, Susan Margaret (1986)
Assistant Professor of English; B.A., University of New Hampshire, 1978.
Hettinger, Stanley D. (1965)
Associate Professor of Music; M.M.E., Vander-Cook College, 1966.
Hibschweiler, Rita A. (1988)
Assistant Professor of Mathematics; Ph.D., State University of New York at Albany, 1988.
Hiller, Marc D. (1984)
Associate Professor of Health Management and Policy; Dr.P.H., University of Pittsburgh, 1978.
Hines, Mark E. (1984)
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Hinson, Edward K. (1985)
Associate Professor of Mathematics; Ph.D., Northwestern University, 1985.
Hodges, Donald G. (1989)
Assistant Professor of Natural Resources Management; Ph.D., University of Georgia at Athens, 1988.
Hoffman, Benjamin H. (1990)
Adjunct Assistant Professor of Biomedical Engineering; M.D., Mt. Sinai School of Medicine, 1983.
Hollweg, Joseph (1980)
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Holter, James B. (1963)
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Hornbeck, James W. (1979)
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Horne, Peter J. (1984)
Director of Cooperative Extension Service and Associate Professor of Adult Education; Ed.D., Boston University, 1980.
Horrigan, James O. (1966)
Professor of Accounting and Finance; Ph.D., University of Chicago, 1967.
Hosseini, Jinoos A. (1987)
Associate Professor of Information Systems; Ph.D., University of Arizona, 1981.
Houston, Barbara (1991)
Associate Professor of Education; Ph.D., University of Western Ontario, Canada, 1977.
Howard, Cleveland L. (1969)
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Howard, Theodore E. (1981)
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Howell, David L. (1982)
Professor of Vocational-Technical Education; Ph.D., Ohio State University, 1973.
Howell, W. Huntting (1980)
Associate Professor of Zoology; Ph.D., University of Rhode Island, 1980.
Hubbard, Colin D. (1967)
Professor of Chemistry; Ph.D., University of Sheffield, England, 1964.
Huk, Romana C. (1987)
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Ikawa, Miyoshi (1990)
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Jacoby, A. Robb (1961)
Professor of Mathematics; Ph.D., University of Chicago, 1946.
Jahnke, Leland S. (1977)
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Jansen, Edmund F., Jr. (1969)
Professor of Resource Economics; Ph.D., North Carolina State University, 1966.
Janson-Sand, Colette H. (1981)
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.
Johnson, Karen R. (1986)
Associate Professor of Nursing; Ed.D., University of Massachusetts at Amherst, 1976.
Johnson, Paul C. (1979)
Associate Professor of Entomology; Ph.D., Cornell University, 1974.
Johnson, Richard P. (1985)
Professor of Chemistry; Ph.D., Syracuse University, 1976.
Jones, Carroll J. (1990)
Assistant Professor of Animal Science; D.V.M., Tufts University, 1984.
Jones, Paul R. (1956)
Professor of Chemistry; Ph.D., University of Illinois at Urbana, 1956.
Jones, Stephen H. (1989)
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Jones, William R. (1962)
Professor of History; Ph.D., Harvard University, 1958.
Kaen, Fred R. (1973)
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Kalinowski, Michael F. (1980)
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Karson, Marvin J. (1983)
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Katz, Ruth M. (1988)
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Kayser, John R. (1969)
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Kerns, Georgia (1991)
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Kennard, Jean E. (1975)
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Kertzer, Robert (1965)
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Khleif, Bud B. (1967)
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Kiang, Yun-Tzu (1970)
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Kies, Christopher (1979)
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Kingston, Richard S. (1988)
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Kinner, Nancy E. (1983)
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Klein, Anita S. (1985)
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LaCourse, John R. (1980)
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Larson, David L. (1965)
Professor of Political Science; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1963.
Laudano, Andrew P. (1986)
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Laue, Thomas M. (1984)
Associate Professor of Biochemistry; Ph.D., University of Connecticut, 1981.
Lawson, John H. (1986)
Professor of Education; Ed.D., Boston University, 1958.
Leak, William B. (1967)
Adjunct Associate Professor of Forest Resources; M.F., S.U.N.Y. College of Environmental Science and Forestry at Syracuse, 1956.
Lee, Martin A. (1984)
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Lee, Thomas D. (1980)
Associate Professor of Plant Biology; Ph.D., University of Illinois at Urbana, 1980.
Leighton, Charles H. (1956)
Professor of Spanish; Ph.D., Harvard University, 1961.
Levin, Robert E. (1982)
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.
Lieber, Rochelle (1981)
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Limber, John E. (1971)
Associate Professor of Psychology; Ph.D., University of Illinois at Urbana, 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.
Linder, Ernst (1987)
Assistant Professor of Mathematics; Ph.D., Pennsylvania State University, 1987.
Lindsay, Bruce E. (1976)
Associate Professor of Resource Economics; Ph.D., University of Massachusetts at Amherst, 1976.
Linsky, Arnold S. (1966)
Professor of Sociology; Ph.D., University of Washington, 1966.
Litvaitis, John A. (1985)
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Loder, Theodore C., III (1972)
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Lofty, John S. (1991)
Assistant Professor of English; Ph.D., University of Michigan at Ann Arbor, 1986.
Long, David F. (1948)
Professor of History; Ph.D., Columbia University, 1950.
Loy, J. Brent (1967)
Professor of Plant Biology and Genetics; Ph.D., Colorado State University, 1967.
Lucas, Karen (1989)
Adjunct Assistant Professor of Communication Disorders; Ph.D., University of Cincinnati, 1978.
Lynch, Katheryn R. (1990)
Assistant Professor of Nursing; D.N. Sc., Boston University, 1989.
Lyons, William Berry (1980)
Adjunct Associate Professor of Earth Sciences; Ph.D., University of Connecticut, 1979.
MacFarlane, Lisa Watt (1987)
Assistant Professor of English; Ph.D., University of Michigan at Ann Arbor, 1987.
MacHardy, William E. (1972)
Professor of Plant Pathology and Extension Plant Pathologist; Ph.D., University of Rhode Island, 1970.
Mair, Robert G. (1985)
Associate Professor of Psychology; Ph.D., Brown University, 1979.
Malley, James P. (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)
Assistant Professor of Resource Economics; Ph.D., Kansas State University, 1986.
Margolin, Aaron B. (1988)
Assistant Professor of Microbiology; Ph.D., University of Arizona, 1986.
Mathieson, Arthur C. (1965)
Professor of Plant Biology; Ph.D., University of British Columbia, 1965.
Mathur, Virendra K. (1974)
Professor of Chemical Engineering; Ph.D., University of Missouri at Rolla, 1970.
Mautz, William W. (1969)
Professor of Wildlife Ecology; Ph.D., Michigan State University, 1969.
Mayer, John D. (1989)
Assistant Professor of Psychology; Ph.D., Case Western Reserve University, 1982.
Mayewski, Paul A. (1974)
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Mayne, Howard R. (1985)
Associate Professor of Chemistry; Ph.D., University of Manchester, England, 1977.
McBride, Mekeel (1979)
Associate Professor of English; B.A., Mills College, 1972.
McCann, Francis D., Jr. (1971)
Professor of History; Ph.D., Indiana University at Bloomington, 1967.
McCartney, Kathleen (1987)
Associate Professor of Psychology; Ph.D., Yale University, 1982.
McDowell, William H. (1989)
Assistant Professor of Water Resources Management; Ph.D., Cornell University, 1982.
McHugh, John Philip (1986)
Assistant Professor of Mechanical Engineering; Ph.D., University of Michigan at Ann Arbor, 1986.
McMahon, Gregory (1988)
Assistant Professor of History; Ph.D., University of Chicago, 1988.
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.
Mebert, Carolyn J. (1979)
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Meeker, Loren D. (1970)
Professor of Mathematics; Ph.D., Stanford University, 1965.
Mejías-López, William (1988)
Assistant Professor of Spanish; Ph.D., University of California at Berkeley, 1988.
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)
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Meredith, Dawn C. (1987)
Assistant Professor of Physics; Ph.D., California Institute of Technology, 1987.
Merenda, Michael J. (1977)
Associate Dean of Whittemore School and Associate Professor of Strategic Management; Ph.D., University of Massachusetts at Amherst, 1978.
Merton, Andrew H. (1972)
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Messier, Victor R. (1970)
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Messner, Richard A. (1985)
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Miller, W. Thomas, III (1979)
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Mills, Richard L. (1967)
Associate Professor of Economics; Ph.D., Indiana University at Bloomington, 1967.
Minocha, Subhash C. (1974)
Professor of Plant Biology and Genetics; Ph.D., University of Washington, 1974.
Mitchell, James R. (1964)
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Möbius, Eberhard (1990)
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Moore, David W. (1972)
Professor of Political Science; Ph.D., Ohio State University, 1970.
Morris, Douglas E. (1984)
Associate Professor of Resource Economics; Ph.D., Oklahoma State University, 1972.
Morrison, Eileen F. (1990)
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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.
Mulhern, John E., Jr. (1954)
Professor of Physics; Ph.D., Boston University, 1954.
Murdoch, Joseph B. (1952)
Professor of Electrical Engineering; Ph.D., Case Institute of Technology, 1962.
Murray, Frederick P. (1966)
Adjunct Associate Professor of Communication Disorders; Ph.D., University of Denver, 1966.
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.
New, Rebecca S. (1990)
Assistant Professor of Education; Ed.D., Harvard University, 1984.
Newkirk, Thomas R. (1977)
Professor of English; Ph.D., University of Texas at Austin, 1977.
Nicoloff, Philip L. (1954)
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Niman, Neil B. (1985)
Associate Professor of Economics; Ph.D., University of Texas at Austin, 1985.
Nisbet, Jane A. (1987)
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Nitschke, Dale F. (1990)
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Noda, Chifuru (1989)
Assistant Professor of Chemistry; Ph.D., Stanford University, 1988.
Nordgren, Eric A. (1964)
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O'Brien, Edward J. (1988)
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O'Connell, Lawrence W. (1966)
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O'Neil, Eileen A. (1985)
Assistant Professor of Health Management and Policy; J.D., Creighton University, 1975.
Oja, Sharon N. (1977)
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Olson, David P. (1964)
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Olson, Richard R. (1988)
Assistant Professor of Zoology; Ph.D., Harvard University, 1984.
Onosko, Joseph J. (1989)
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Orovich, Nicholas N. (1987)
Associate Professor of Music; M.M., New England Conservatory of Music, 1978.
Ossenbruggen, Paul J. (1975)
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Page, Lincoln R. (1984)
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Palais, Julie M. (1988)
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Palmer, Stuart (1955)
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Pearson, David A. (1989)
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Peirce, Lincoln C. (1964)
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Pekins, Peter J. (1987)
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Person, Mark A. (1990)
Assistant Professor of Hydrogeology; Ph.D., Johns Hopkins University, 1990.
Petillo, Juliette D. (1973)
Associate Professor of Nursing; M.S., Boston University, 1973.
Pettigrew, Neal R. (1981)
Adjunct Associate Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1981.
Pierce, Robert S. (1967)
Adjunct Professor of Forestry and Soil and Water Science; Ph.D., University of Wisconsin at Madison, 1957.
Pilar, Frank L. (1957)
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Pilgrim, Sidney A. L. (1979)
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Pistole, Thomas G. (1971)
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Planalp, Roy P. (1987)
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Pokoski, John L. (1967)
Professor of Electrical Engineering; Ph.D., Montana State University, 1967.
Polasky, Janet L. (1981)
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Polk, Keith (1964)
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Pollard, James E. (1970)
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Porter, Phoebe A. (1988)
Assistant Professor of Spanish; Ph.D., Brown University, 1985.
Prevost, Fernand J. (1987)
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Puth, Robert C. (1967)
Professor of Economics; Ph.D., Northwestern University, 1967.
Quinn, Timothy J. (1989)
Assistant Professor of Physical Education; Ph.D., Michigan University, 1987.
Rasmussen, Mary H. (1968)
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Reeves, R. Marcel (1964)
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Reid, R. Dan (1987)
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Renoldi-Tocalino, Magda A. (1989)
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Rentschler, Dorothy D. (1990)
Associate Professor of Nursing; Ph.D., New York University, 1986.
Ritvo, 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, Betty Holroyd (1974)
Professor of Social Work; Ph.D., Brandeis University, 1975.
Roberts, John M. (1979)
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Roberts, Lewis, Jr. (1972)
Dean of University of New Hampshire at Manchester and Associate Professor of Occupational Education; Ed.D., Auburn University, 1972.
Rock, Barrett N. (1987)
Associate Professor of Natural Resources and Earth, Oceans, and Space; Ph.D., University of Maryland, 1972.
Rodgers, Frank G. (1985)
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Rogers, John E. (1967)
Professor of Music; M.F.A., Princeton University, 1966.
Rogers, Owen M. (1959)
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Romoser, George K. (1961-62, 1967)
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Rosenberg, Pearl M. (1990)
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Ross, Shepley L. (1955)
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Routley, Douglas G. (1957)
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Rucinski, Andrzej (1984)
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Russell, Robert D. (1975)
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Russell, Sylvia Weber (1982)
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Ryan, James M. (1984)
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Safford, Lawrence O. (1981)
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Sale, Peter F. (1988)
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Salloway, Jeffrey Colman (1988)
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Salyer, Lucy E. (1989)
Assistant Professor of History; Ph.D., University of California at Berkeley, 1989.
Samuels, Frederick (1966)
Professor of Sociology; Ph.D., University of Massachusetts at Amherst, 1966.
Sasner, John J., Jr. (1965)
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Savage, Godfrey H. (1965)
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Sawyer, Philip J. (1990)
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Schibanoff, Susan (1971)
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Schlobohm, Starr F. (1975)
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Schmidt, Torsten (1988)
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Schram, Thomas H. (1990)
Assistant Professor of Education; Ph.D., University of Oregon, 1990.
Schwab, Charles G. (1975)
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Schwarz, Marc L. (1967)
Associate Professor of History; Ph.D., University of California at Los Angeles, 1965.
Schweickart, Patrocinio P. (1979)
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Scott, Michelle P. (1990)
Assistant Professor of Zoology; Ph.D., Harvard University, 1984.
Seavey, John W. (1980)
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Seidel, Lee F. (1977)
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Seiler, David E. (1972)
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Seitz, W. Rudolf (1976)
Professor of Chemistry; Ph.D., Massachusetts Institute of Technology, 1970.
Selikowitz, Stuart M. (1987)
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Sethuraman, Ramachandran (1989)
Assistant Professor of English; Ph.D., University of Florida, 1989.
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.
Sherwood, James A. (1986)
Assistant Professor of Mechanical Engineering; Ph.D., University of Cincinnati, 1987.
Shetty, Sandhya (1988)
Assistant Professor of English; Ph.D., University of Rochester, 1987.
Shippee-Rice, Raelene (1979)
Associate Professor of Nursing; Ph.D., Brandeis, 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; Ph.D., University of Alaska at Faribanks, 1981.
Siggelakis, Susan J. (1988)
Assistant Professor of Political Science; Ph.D., Johns Hopkins University, 1988.
Simic, Charles D. (1973)
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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.
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, C. Tattersall (1982)
Associate Professor of Forest Ecology and Soils; Ph.D., University of Maine at Orono, 1984.
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., New York University, 1987.
Smith, Samuel C. (1961)
Professor of Animal Science and Biochemistry; Ph.D., Pennsylvania State University, 1962.
Sohl, Jeffrey E. (1983)
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Sower, Stacia A. (1982)
Associate Professor of Zoology and Biochemistry; Ph.D., Oregon State University, 1980.
Sparr, Ted Martin (1989)
Professor of Computer Science; Ph.D., Texas A&M University, 1972.
Spears, Margaret W. (1981)
Associate Professor of Nursing; Ed.D., Vanderbilt University, 1985.
Spencer, Mary Jo (1981)
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Spillane, Kathleen Wilson (1986)
Assistant Professor of Music; Ed.D., Columbia University, 1987.
Sprague, Linda G. (1969)
Professor of Operations Management; D.B.A., Harvard University, 1973.
Sproul, Otis J. (1982)
Dean of the College of Engineering and Physical Sciences and Professor of Civil Engineering; Sc.D., Washington University, 1961.
Steiner, Adrienne McElwain (1984)
Associate Professor of Economics; Ph.D., Duke University, 1980.
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, Eilzabeth A.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.
Straus, Murray A. (1968)
Professor of Sociology; Ph.D., University of Wisconsin at Madison, 1956.
Sullivan, Judith A. (1990)
Professor of Nursing; Ed.D., University of Rochester, 1972.
Sullivan, Patricia A. (1988)
Assistant Professor of English; Ph.D., Ohio State University, 1988.
Sundberg, Donald C. (1978)
Executive Director of Sponsored Research and Associate Professor of Chemical Engineering; Ph.D., University of Delaware, 1970.
Swift, M. Robinson (1976)
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Taft, Charles K. (1967)
Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1960.

Tagliaferro, Anthony R. (1978)
Associate Professor of Animal Science and Nutrition; Ph.D., Cornell University, 1978.
Talbot, Robert W. (1988)
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Taylor, James T. (1977)
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Taylor, Robert L., Jr. (1984)
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)
Adjunct Assistant Professor of Entomology and State Entomologist; Ph.D., University of Missouri at Columbia, 1977.
Thompson, Allen R. (1974)
Associate Professor of Economics; 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)
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Torbert, Roy B. (1989)
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Trout, B. Thomas (1969)
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Trubowitz, Rachel (1986)
Assistant Professor of English; Ph.D., Columbia University, 1985.
Tsang, Paul C. (1989)
Assistant Professor of Animal Science; Ph.D., Boston University, 1986.
Tse, Siu-Keung (1984)
Associate Professor of Mathematics; Ph.D., University of Wisconsin at Madison, 1984.
Turner, Elise H. (1990)
Assistant Professor of Computer Science; Ph.D., Georgia Institute of Technology, 1989.
Turner, Heather (1991)
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Turner, Roy M. (1990)
Research Assistant Professor of Computer Science; Ph.D., Georgia Institute of Technology, 1989.
Ulrich, Gael D. (1970)
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.
Urban, Willard E., Jr. (1963)
Professor of Biometrics and Genetics; Ph.D., Iowa State University, 1963.
Urquhart, Peter W. (1989)
Assistant Professor of Music; Ph.D., Harvard University, 1988.
Vagts, Peggy A. (1978)
Associate Professor of Music; M.M., University of Wisconsin at Madison, 1978.
Van Osdol, Donovan H. (1970)
Professor of Mathematics; Ph.D., University of Illinois at Urbana, 1969.
Vaske, Jerry J. (1988)
Research Associate Professor of Resource Economics; Ph.D., University of Maryland, 1980.
Vasudevan, Palligarnai T. (1988)
Assistant Professor of Chemical Engineering; Ph.D., Clarkson University, 1988.
Veal, Larry J. (1982)
Assistant Professor of Music; M.M. Cello, University of Illinois at Urbana, 1976.
Verrette, Paul F. (1962)
Associate Professor of Music; M.A., Boston University, 1971.
Vestrand, W. Thomas (1987)
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Vidal, Fernando (1990)
Assistant Professor of Psychology; Ph.D., University of Geneva, 1988.
Voll, John O. (1965)
Professor of History; Ph.D., Harvard University, 1969.
Vroman, Neil B. (1984)
Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1982.
Walker, Charles W. (1976)
Professor of Zoology; Ph.D., Cornell University, 1976.
Wang, Li-ying Hilary (1989)
Assistant Professor of Family and Consumer Studies; Ph.D., Cornell University, 1991.
Wang, Rosemary Y. (1971)
Associate Professor of Nursing; Ph.D., Boston College, 1982.
Wang, Tung-Ming (1961)
Professor of Civil Engineering; Ph.D., Northwestern University, 1960.
Wansart, William L. (1985)
Associate Professor of Education; Ed.D., University of Northern Colorado, 1984.
Ward, Larry G. (1989)
Research Assistant Professor of Earth Sciences; Ph.D., University of South Carolina, 1978.
Ward, Sally K. (1980)
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Warner, Rebecca M. (1981)
Associate Professor of Psychology; Ph.D., Harvard University, 1978.
Watson, Winsor H., III (1978)
Associate Professor of Zoology; Ph.D., University of Massachusetts at Amherst, 1978.
Watt, David W. (1987)
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Watters, David H. (1978)
Associate Professor of English; Ph.D., Brown University, 1978.
Weathersby, Rita (1978)
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Webb, Dwight (1967)
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Webber, William R. (1969)
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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)
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Weiner, James L. (1979)
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Weisman, Gary R. (1977)
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Wells, Otho S. (1966)
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Wetzel, William E., Jr. (1967)
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Weyrick, Richard R. (1970)
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Wheeler, Douglas L. (1965)
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White, Sally A. (1988)
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White, Susan O. (1969)
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Wible, James R. (1984)
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Wicklow, Barry J. (1989)
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Williams, Carol L. (1978)
Associate Professor of Nursing; D.N.Sc., Catholic University of America, 1979.
Williams, Daniel C. (1970)
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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.
Woodward, William R. (1975)
Associate Professor of Psychology; Ph.D., Yale University, 1975.

Wright, John J. (1970)
Professor of Physics; Ph.D., University of New Hampshire, 1969.
Wrightsman, Dwayne E. (1964)
Professor of Finance; Ph.D., Michigan State University, 1964.
Yount, John A. (1962-64, 1965)
Professor of English; M.F.A., University of Iowa, 1962.
Zaso, Gus C. (1970)
Associate Professor of Leisure Management and Tourism; Re.D., Indiana University at Bloomington, 1966.
Zia, Lee L. (1985)
Associate Professor of Mathematics; Ph.D., Brown University, 1985.
Zsigray, Robert M. (1970)
Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1969.

Committees of the Graduate School

Graduate Council

Raymond L. Erickson, Ph.D.
Dean of the Graduate School, Chairperson

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

A. Linn Bogle, Ph.D.
Professor of Botany

Russell T. Carr, Ph.D.
Associate Professor of Chemical Engineering

Grant L. Cioffi, Ph.D.
Associate Professor of Education

Charles E. Clark, Ph.D.
Professor of History

John F. Dawson, Ph.D.
Professor of Physics

James F. Haney, Ph.D.
Professor of Zoology

Robert Hapgood, Ph.D.
Professor of English

Anita S. Klein, Ph.D.
Associate Professor of Biochemistry and Genetics

Lawrence W. O'Connell, Ph.D.
Associate Professor of Political Science

David A. Pearson, Ph.D.
Professor of Health Management and Policy

Three graduate students are appointed to this council each year.

Research Council

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

Raymond L. Erickson, Ph.D.
Dean of the Graduate School

Jane A. Hansen, Ph.D.
Associate Professor of Education

Nancy E. Kinner, Ph.D.
Associate Professor of Civil Engineering

Carolyn J. Mebert, Ph.D.
Associate Professor of Psychology

Robert L. Taylor, Ph.D.
Associate Professor of Animal Science and Genetics

Two faculty members from the College of Life Sciences and Agriculture, one from the College of Engineering and Physical Sciences, two from the College of Liberal Arts, one from the School of Health and Human Services, and one from the Whittemore School of Business and Economics will be appointed in the fall. Two graduate students are appointed to the council each year.

Student Fellowship Selection Committee

Curtis V. Givan, Ph.D.
Professor of Plant Biology

Raymond Greenlaw, Ph.D.
Assistant Professor of Computer Science

James B. Lewis, Sc.D.
Assistant Professor of Health Management and Policy

R. Dan Reid, Ph.D.
Assistant Professor of Business Administration

Rachel Trubowitz, Ph.D.
Assistant Professor of English

Faculty Fellowship Selection Committee

William M. Baum, Ph.D.
Professor of Psychology

Arthur C. Borror, Ph.D.
Professor of Zoology

Stephen N. Calculator, Ph.D.
Associate Professor of Communication Disorders

Marie A. Gaudard, Ph..D.
Associate Professor of Mathematics

Torsten Schmidt, Ph.D.
Assistant Professor of Economics

Tuition Scholarship Selection Committee

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

Jean Benoit, Ph.D.
Associate Professor of Civil Engineering

Mark S. Deturk, Ph. D.
Assistant Professor of Music

Karen R. Johnson, Ed.D.
Associate Professor of Nursing

Michael J. Merenda, Ph.D.
Associate Professor of Business Administration

Paul C. Tsang, Ph.D.
Assistant Professor of Animal Science

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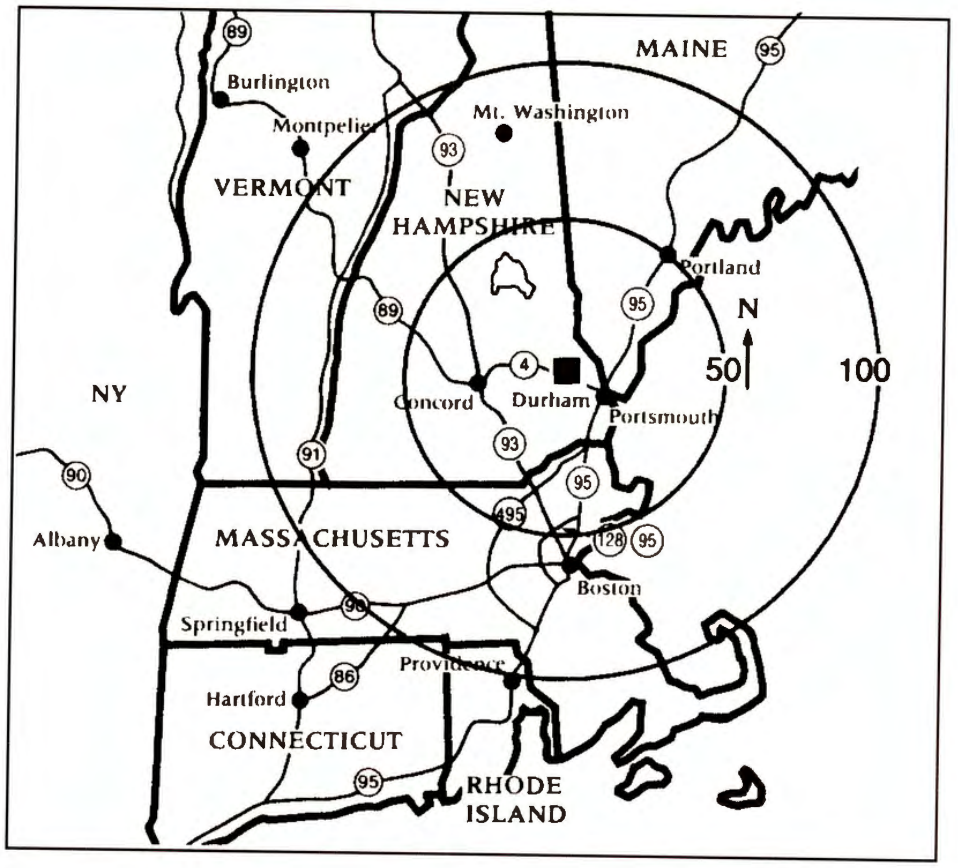


By Car FROM BOSTON, MASS. Follow I-95 North. When approaching the Portsmouth, N.H., area, take the exit bearing left, marked "NH Lakes and White Mountains, Routes 4 & 16." Continue on that road to Exit 6W (Concord-Durham) and follow Route 4 West. Exit at 155A and turn toward Durham. Follow 155A through a short stretch of farmlands and fields to the UNH campus.

FROM HARTFORD, CONN. Take I-84/I-86 East out of Hartford to the Mass. Pike (I-90) to Auburn Exit 10 then East on I-290 to I-495 North. Drive east on I-495 North, Exit 26. Continue north on I-95, then follow the directions above for driving from Boston.

FROM PORTLAND, ME. Follow either I-95 or Route 1 South to the Portsmouth traffic circle. Take the Spaulding Turnpike north to Exit 6W (Concord-Durham). Then follow the directions above for driving from Boston.

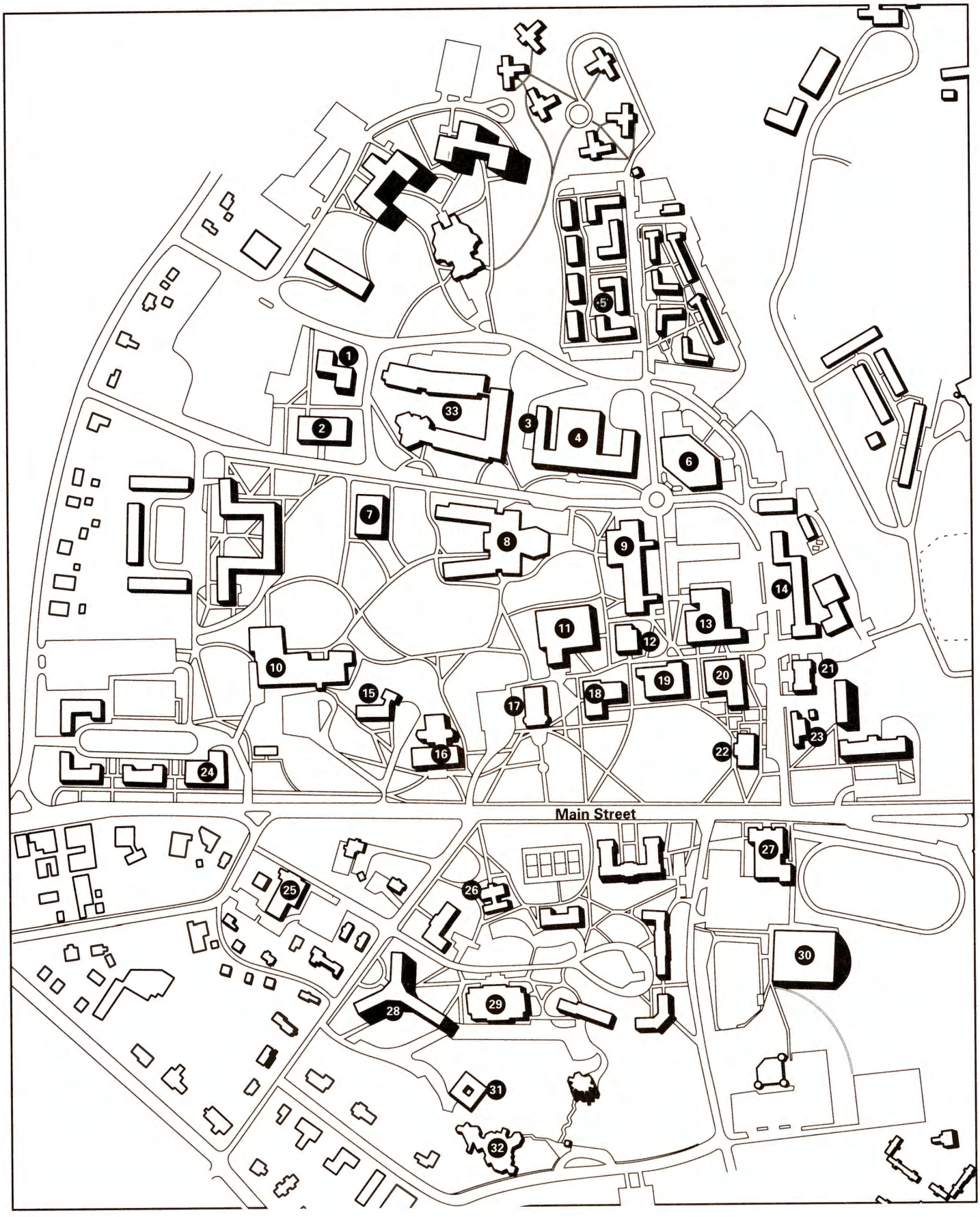
FROM CONCORD, N.H. Follow Route 4 East, and take the UNH/Durham exit at 155A. Follow a short stretch of farmlands and fields to the UNH campus.

FROM MANCHESTER, N.H. Take Route 101 to the junction of Route 125. Follow Route 125 North to the Lee traffic circle. Drive east on Route 4, and then follow the directions above for driving from Concord.

By Plane From Logan International Airport, Boston, you may use the C & J Trailways Airport Bus Service. Advance reservations are not required. For further information call 603-742-5111 or, outside New Hampshire, 800-258-7111.

By Bus Depart C & J Trailways Bus Lines across from South Station in Boston. For further information call 603-742-5111 from New Hampshire or 800-258-7111 outside of New Hampshire.

Campus Map


Main Street
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Key to Campus Map

1 Babcock House
2 McConnell Hall
3 Marine Programs Building
4 Kingsbury Hall
5 Forest Park Apartments
6 Science & Engineering Research Building
7 Horton Social Science Center
8 Paul Creative Arts Center
9 Spaulding Life Sciences Center
10 Memorial Union Building
11 Dimond Library
12 Conant Hall
13 Hewitt Hall
14 Service Building
15 Hood House
16 Hamilton Smith Hall
17 Thompson Hall
18 Murkland Hall
19 Demeritt Hall
20 James Hall
21 Pettee Hall
22 Morrill Hall
23 Taylor Hall
24 Huddleston Hall
25 Health Services Building
26 Smith Hall
27 New Hampshire Hall
28 Stoke Hall
29 Stillings Dining Hall
30 Snively Arena
31 New England Center Administration Building
32 New England Center
33 Parsons Hall

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The University of New Hampshire has adopted a grievance procedure to provide for the resolution of complaints under this policy. A copy of the grievance procedure may be obtained through the Vice President for Academic Affairs Office, Thompson Hall.

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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.

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