BULLETIN OF THE UNIVERSITY OF NEW HAMPSHIRE
GRADUATE SCHOOL ISSUE
The Graduate School 1978-79

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Skiing... 90 minute drive
Beaches... 20 minute drive
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Graduate Degree Programs

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

Master of Science
Animal Sciences
Biochemistry
Biology
Botany
Chemical Engineering
Chemistry
Civil Engineering
Computer Science
Earth Sciences
  Geology
  Oceanography
Electrical Engineering
Entomology
Genetics
Home Economics
Mathematics
Mechanical Engineering
Microbiology
Music Education
Natural and Environmental Resources
  Forest Resources
  Hydrology
  Resource Economics
  Soil Science
  Resource Administration and Management
  Wildlife Ecology
Physical Education
Physics
Plant Science
Zoology

Master of Arts in Teaching
  Elementary Education
  Secondary Education

Master of Science for Teachers
Biology
Chemistry
English
Mathematics
Physics
Spanish

Master of Occupational Education

Master of Business Administration

Master of Education
Administration and Supervision
Counseling and Personnel Service
Developmental Disabilities
Early Childhood
Elementary Education
Preservice
Reading
Secondary Education

Master of Public Administration
Political Science

Doctor of Philosophy
Biochemistry
  Nutrition
Botany
Chemistry
Economics
Engineering
  Signal Processing
  Transport Phenomena
  System Design
  Theory and Applied Mechanics
English
Genetics
History
Mathematics
Mathematics Education
Microbiology
Physics
Plant Science
Psychology
Sociology
Zoology
Graduate Education
At the University of New Hampshire

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

Graduate education is supervised by a graduate faculty of over 400. The Graduate School is led by the dean, who implements the policies of the graduate faculty. The Graduate Council is composed of elected faculty and student representatives and serves in an advisory capacity to the dean.

Quality graduate education requires development of new knowledge and communication of existing knowledge. The dedicated teaching faculty carry on an active research program which supports graduate education by developing new knowledge and providing training opportunities for graduate students in residence. As one of the nation's 71 land grant institutions, the University is responsible for conducting research and disseminating information to the public in areas affecting the nation's welfare.

The University of New Hampshire is the only university in the state of New Hampshire, and is the University System of New Hampshire institution charged with providing graduate programs which meet state and regional needs. Doctoral programs are offered exclusively on the University campus although other units of the University System offer some master's programs.

Master's Programs

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

Doctoral Programs

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

Interdisciplinary Programs

Many of the problems faced by modern society demand that students be trained in more than one of the traditional academic disciplines. Consequently, the Graduate School encourages programs which involve the faculty of more than one discipline or department. This may be done through such formal organizations as the Genetics Program, which involves geneticists from many departments in both master's and doctoral programs; or the Institute of Natural and Environmental Resources, which brings together resource economists, foresters, wildlife specialists, hydrologists, and soil scientists to address the problems of our environment; or the Intercollege Biological Sciences Organization, which makes the resources of the biological science departments available to students in master's programs designed for secondary and junior college teachers. Several options for interdisciplinary study also exist under the Marine Program (see p. 10). To encourage the development of additional interdisciplinary opportunities, the graduate faculty recently adopted procedures which permit establishment of interdisciplinary options within established doctoral programs. The recently established nutrition option in the Biochemistry Ph.D. program involves nutritionists from the Departments of Biochemistry, Animal Sciences, and Home Economics and is one result of these procedures.

Other forms of cooperation are less formal, as when students from one department work with faculty from other departments to develop a program, thus combining the strengths of several disciplines. An example of this is the Soil and Water-Chemistry Program, which involves faculty in soils and hydrology cooperating with faculty in chemistry. Students in zoology frequently work with faculty in such other departments as animal sciences and entomology to broaden their scope in their graduate programs. In the social sciences, the psychology and sociology departments cooperate in a social-psychology doctoral program. The Engineering Ph.D. Program is a cooperative, interdisciplinary effort of the electrical and computer engineering, civil engineering, mechanical engineering, and chemical engineering departments.

Students in all programs are encouraged to identify, with their advisers, courses outside of their disciplines that are appropriate to their professional goals.
Teaching, Service, and Research

Research is an essential part of graduate education. It sustains a continuing infusion of knowledge, enhances the level of instruction, extends the frontiers of understanding, and makes human progress possible. It provides an opportunity for graduate students to learn by working with instructors on independent projects or as part of research teams. Ultimately, the goal is to share discoveries and applications with others in the state, region, and world. To ensure that the University's research efforts are closely tied to its educational efforts, the dean of the Graduate School is also director of research.

Research and Service Facilities

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

Among the centers are the Center for Industrial and Institutional Development, the Water Resources Research Center, and the Resources Development Center—all of which provide specialized research and service to New Hampshire business, industry, and government. The Marine Program, supported by an institutional Sea Grant Award and state funding, has facilities both on campus and the Jackson Estuarine Laboratory. The Space Science Center and Engineering Design and Analysis Laboratory provide highly specialized facilities for faculty and graduate students to participate in sophisticated engineering and science research projects.

The Public Administration Service acts as a consultant group for town and city officials. The Agricultural Experiment Station, one of the largest research and service units at the University, provides research, information, and testing for the state agricultural industry. The Ritzman Animal Nutrition Laboratory offers specialized research facilities. The recently established University Instrumentation Center coordinates the utilization of many highly specialized instruments and provides service to the many researchers on campus using instruments such as mass spectrometers, spectrophotometers, nuclear magnetic resonance spectrometers, amino acid analyzers, etc. The University Instrumentation Center has established a new electron microscope facility which houses a transmission electron microscope and electron microprobe and a scanning electron microscope. The DEC 10 system, the principal facility for the University Computer Center, is used by students from all disciplines on campus.
Marine Program: The University's central location on the northern New England coast near a variety of estuarine, coastal, insular, and continental-shelf environments has fostered a broad range of marine educational and research activities for many years. These varied activities, which occur within all of the University's colleges, are coordinated and supported by the Marine Program. Both master's and Ph.D. degree programs are offered on a departmental and interdisciplinary basis in the areas of marine physical, life, and social sciences; ocean engineering; and physical education. Departments involved are animal science, biochemistry, botany, chemistry, chemical engineering, civil engineering, earth sciences, electrical and computer engineering, mathematics and computer science, mechanical engineering, microbiology, physical education, political science, sociology and anthropology, and zoology. Also involved are the Institute of Natural and Environmental Resources and the Whittmore School of Business and Economics.

Marine research by faculty and students proceeds on both an intra- and interdisciplinary basis and is supported by University and private funds as well as by organizations such as the National Science Foundation, the Office of Naval Research, the National Institutes of Health, the U.S. Coast Guard, the Woods Hole Oceanographic Institution, Sanders Associates, and the National Sea Grant Program. UNH and the University of Maine together are a Sea Grant Institution.

Marine research activities are principally pursued in the neighboring environments of the Great Bay estuarine system, the coastal zone, the near-shore coastal zone, the Isles of Shoals, and the Gulf of Maine, but also in the more remote areas of the world such as the North Sea and the Arctic, Antarctic, and mid-Pacific Oceans. Some examples of research studies include those relating to marine food chains; marine biotoxins; trace metals; biological and thermal pollution; marine mineral resources; mariculture; marine resource management; marine law; environmental base-line studies; arctic under-ice systems; diving systems; submersibles, underwater habitats, and sealabs; and buoy systems and breakwaters.

Facilities specifically supporting graduate education and research include those on the University's campus—the Marine Program building, the Engineering Design and Analysis Laboratory, and the Mechanics Research Laboratory—and those off campus—the Jackson Estuarine Laboratory, the Diamond Island Ocean Engineering Station, the Shoals Marine Laboratory, a near-coast pier facility, and the RV Jere Chase together with several smaller vessels and facilities used in cooperation with other institutions such as MIT and the Woods Hole Oceanographic Institution. In addition, the excellent University diving program directly supports research and annually qualifies numerous faculty and student divers.

The Marine Program building houses work spaces for ocean engineering, physical sciences, and other marine activities, as well as the Marine Program Office. The Engineering Design and Analysis Laboratory serves faculty and students from the
four engineering departments and others associated with its activities supporting projects and applied research in the marine environment. The Mechanics Research Laboratory, an entity within the Department of Mechanical Engineering, emphasizes both theoretical and applied engineering research in the ocean environment. The Jackson Estuarine Laboratory, located on Great Bay about five miles from the campus and fourteen miles from the ocean via the Piscataqua River, supports the research of the marine life sciences and earth sciences departments. Research vessels dock at the adjacent pier. The Diamond Island Ocean Engineering Station, located about forty miles from Durham on Diamond Island in Lake Winnipesaukee, furnishes an excellent fresh-water testing site for ocean systems. The Shoals Marine Laboratory, located about seven miles off the New Hampshire coast on Appledore Island of the Isles of Shoals, is a joint facility of UNH and Cornell, and is principally concerned with marine life sciences educational and research activities. A near-coast pier facility, situated about ten miles from Durham in Portsmouth, New Hampshire, and two miles from the ocean on the Piscataqua River, serves research vessels up to approximately 50 feet in length and commercial fishing boats of the
The R/V Jere Chase is a 45-foot research vessel equipped for a wide variety of marine research activities in the estuarine and near-coast waters.

The New England Center for Continuing Education is adjacent to campus. This architecturally striking complex was built with a gift from the Kellogg Foundation and is supported by the six New England state universities. The center provides residence and conference facilities for a wide variety of adult education programs. A closed circuit TV system permits conference programs to be reviewed in the participants' rooms.

Library

The University Library houses over 750,000 volumes, 6,000 periodicals, and substantial microform and audio-tape collections. Specialized subject collections are housed in four branches: chemistry in Parsons Hall, engineering and mathematics in Kingsbury Hall, biological sciences in Kendall Hall, and physics in DeMeritt Hall. The branches are administered by a physical sciences librarian and a biological sciences librarian. Media Services, a department of the library, offers a large film collection, equipment loans including projectors and portable TV cameras and monitors, photographic and graphic design assistance, and audiovisual project consultation.

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

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

During the regular academic year, the library is open seven days a week. On vacations and during the summer, a more limited schedule is in effect.
Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided the applicant's undergraduate record is satisfactory. It is the policy of the University of New Hampshire not to discriminate on the basis of sex, race, color, age, religion, national origin, or handicap in its recruitment and admission of students or awarding of financial aid, in accordance with all relevant federal and state laws and regulations.

Applicants for admission must present evidence that they have had the necessary academic preparation to enable them to pursue the graduate program for which they are applying. Candidates for admission must have a superior undergraduate record. An applicant who has undertaken graduate work at another institution should have completed the courses or program attempted with a record equivalent to that required for graduate students to remain in good academic standing at UNH.

Individual programs may designate specific requirements that applicants must meet; such requirements may include the scores achieved on the aptitude and appropriate advanced sections of the Graduate Record Examination or the Graduate Management Admission Test, or specific undergraduate preparation. The program descriptions listed in this catalog and the information sheet supplied with the application forms should be consulted for these special requirements.

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

The number of applicants to some graduate programs exceeds the number that can be accommodated by the University faculty and facilities; thus, not all qualified applicants can be admitted. To insure the greatest opportunity for admission, applicants should submit their applications by the deadlines listed on page 17.
Application Procedures

An applicant for admission must submit directly to the Graduate School, Social Science Center, University of New Hampshire, Durham, New Hampshire 03824, the following materials:

1. The official application forms for admission to graduate study (available from the Graduate School).

2. Two official transcripts, submitted from each institution attended, showing the grades earned in all of the applicant's previous academic work (graduate and undergraduate).

3. Three letters of recommendation (on the Graduate School's recommendation form) from persons in a position to judge the applicant's preparation for and ability to undertake graduate study, e.g., previous instructors or coworkers of the applicant. Letters must be forwarded directly by the writer to the Graduate School. Material from college placement offices must have been prepared within the last twelve months.

4. A $10 application fee. This fee is nonrefundable.

5. Any additional materials, such as the official report of scores achieved on the Graduate Record Examination or Graduate Management Admission Test, which are required by the department or program to which the applicant is applying. Such scores must be forwarded directly from the testing agency and must be from tests taken within five years of the date of application.

6. Completed "Statement on Residence for Applicants to Graduate School at UNH." This form will be included with application forms.

All application material becomes part of the permanent records of the University of New Hampshire and will not be returned.

When the application and all of the required supporting material has been received, the application is reviewed by faculty members of the appropriate programs. This review normally is conducted by an admissions committee composed 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.

Since the specific criteria for admission differ from program to program, it is impossible to itemize all of the factors that are weighed in the admission process. Because of this, the Graduate School has not established such specific criteria as minimum acceptable scores on standardized tests such as the GRE or GMAT. Rather, all of the material that is submitted as part of an application receives careful consideration.

A student who wishes to pursue a degree or program other than the one to which admission was granted originally should file an application for a change in degree
with the Graduate School. The dean of the Graduate School will notify the student of the decision after consulting with the appropriate departments.

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

A New England resident enrolling in a graduate program offered at one of the New England state universities but not offered at the state university in the student's home state is eligible for the tuition rates established under the New England Regional Student Program. Application procedures are in the New England Regional Student Program Graduate Level booklet, available from the New England Board of Higher Education, 40 Grove Street, Wellesley, MA 02181.

In addition to the material noted above, all applicants from non-English-speaking countries must furnish proof of their proficiency in English by submitting scores achieved on the Test of English as a Foreign Language administered by Educational Testing Service. Arrangements for taking this examination should be made directly with the Educational Testing Service, Box 899, Princeton, New Jersey, USA, 08540.

Because of the time involved in processing applications from residents of foreign countries, completed applications and supporting documents should be received at the Graduate School four months prior to the semester for which the admission is desired.

Completed applications and supporting documents should be submitted before July 15 for the first semester, December 15 for the second semester, and April 1 for the summer session. There is no guarantee that applications submitted after these deadlines can be acted upon in time to permit registration in the desired semester. Applicants for financial aid for the following academic year must submit completed applications and supporting documents for admission and financial aid prior to February 15. Applicants to programs in Education should comply with the special deadlines listed in the "Education" section, page 68.

Regular Admission: Regular admission may be granted to those applicants whose academic records and supporting documents indicate that they are fully qualified to undertake graduate study in their chosen field.
Conditional Admission: Conditional admission may be granted to those applicants whose academic records indicate deficiencies but suggest some promise of success in graduate study. Students granted conditional admission must meet the specific requirements stated at the time of their admission. Conditional admission will not be granted to applicants who reside in foreign countries.

Special Students: Individuals holding baccalaureate degrees may register for courses with the approval of the instructor and dean of the Graduate School. They are designated as "special students," and are not admitted to the Graduate School and are not candidates for a graduate degree. Special students register with the Division of Continuing Education in Verrette House on campus and are not required to file an application for admission to the Graduate School. Special students are not normally permitted to register as full-time students.

If a special student is subsequently admitted to a degree program, a maximum of nine credits earned in University of New Hampshire graduate courses as a special student may, upon recommendation of the program faculty, be applied to a student's degree program. The nine credit limitation applies to all courses completed or in process on the date when the official letter of admission is written.

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.

University of New Hampshire Seniors: Qualified senior students in the University of New Hampshire may be admitted to the Graduate School and must have been admitted before enrolling in courses for graduate credit. Such seniors should follow the application procedures outlined on page 16 and should file their applications by the specified dates.

Upon recommendation of the department, superior University of New Hampshire senior students may petition the Graduate School to be allowed to count credits for a maximum of two 800-level courses toward both a bachelor's and master's degree, provided the student has been admitted to the master's program.

Students wishing to enroll in the five-year combined Bachelor/Master of Business Administration programs should consult their advisers concerning the regulations relevant to them.

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

Course Charges and Fees

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.

Tuition/course charges vary depending on the number of credits for which a graduate student registers.

**9-16 Credits per Semester:** Full tuition is charged. New Hampshire residents—$1,150 per academic year ($575 per semester); nonresidents of New Hampshire—$3,500 per academic year ($1,750 per semester).

**1-8 Credits per Semester:** Students are charged according to the number of credits for which they register. Residents, $55 per credit; nonresidents, $150 per credit.

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

The above charges will apply to admitted graduate students enrolling for courses at the University during the academic year. Admitted graduate students planning to enroll for courses at Merrimack Valley College, through the School of Continuing Studies, or during the summer session should consult the relevant catalogs for information regarding fees.

The University reserves the right to adjust rates for tuition, course charges, and fees. Such adjustments will be announced as far in advance as possible.

**Rules Governing Residence Classification:** A student is classified as a resident or a nonresident for tuition purposes at the time of admission to the University. The decision is based upon information furnished by the student's application and any other relevant information.

All applicants living in New Hampshire are required to submit a notarized statement to the effect that they have been legally domiciled in New Hampshire continuously for at least 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 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 on the application for admission, and all students are bound by them.

**Master’s Students:** Master’s students registering for thesis credits (course number 899) will be assessed tuition for their thesis according to the number of thesis credits for which they register in a specific semester until they have registered for the maximum number of thesis credits permitted in their specific program. Master’s students who have previously registered for the maximum number of thesis credits and who are on campus completing their theses will pay a *Continuing Enrollment Charge* of $100 per semester.

Master’s students who are not registered for on-campus work at the time they complete their degree requirements (i.e., examinations, theses) will be assessed an *In Absentia Charge* of $25 one month prior to the conferral of their degree. This charge will not apply to students removing course incompletes.

**Doctoral Students:** Doctoral students who are in residence and engaged in dissertation research must register for Doctoral Research (course number 999). A minimum of two semesters of registration for 999 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. The charge for this registration will be $300 per semester or $150 per summer session.

Doctoral candidates not in residence at the time they complete their degree requirements (i.e., examinations, submission of dissertation) will be assessed an *In Absentia Charge* of $100 one month prior to the conferral of their degree.

A Memorial Union Fee of $17.50 per semester and a Student Services Fee of $5 per semester must be paid by all full-time admitted graduate students. Students registered for fewer than 9 credits pay a Memorial Union Fee of $8.75 per semester, are not liable for the Student Services Fee, but are charged a registration fee of $5 for New Hampshire residents or $10 for nonresidents.

Students may audit courses with the consent of their adviser and the instructor involved. *Charges for auditing a course are the same as taking it for credit.*

University-supported graduate assistants and project assistants receiving the full academic year stipend may be exempted from the payment of tuition and course
Financial Aid

University of New Hampshire Fellowships: A limited number of three-year "University of New Hampshire Fellowships" are awarded to outstanding doctoral students. Each recipient is given an opportunity to spend the first year in full-time study, the second year as a teaching assistant, and the third year as a research assistant. The stipends for this program are $3,300 for the first academic year, $3,500 for the second academic year, and $3,700 for the third academic year. In addition, the award provides $900 support for each of two summers and waiver of tuition. These awards are made by the Graduate School Student Fellowship Selection Committee from nominations from the various programs.

Graduate Merit Scholarships: 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 Merit Scholarship. The Scholarship will supplement the stipend to provide a total level of academic year support of $4,000. Continuation of a Graduate Merit Scholarship into succeeding years will be contingent upon the student's demonstration of superior performance in a doctoral program.

Tuition Scholarships: Up to 50 superior students may be granted academic-year tuition scholarships. These awards provide only for waiver of tuition charges and are
subject to the maintenance of a high scholastic record in the Graduate School. Some superior students may be granted tuition scholarships for the summer session. Applications may be obtained from the Graduate School Office.

**Dissertation Fellowships:** Dissertation Fellowships with stipends of up to $3,300 for a maximum tenure of one academic year are available. These awards include a waiver of the doctoral research registration fee for the period of the award. Applications should be made to the dean of the Graduate School.

**Martin Luther King Assistantships:** Martin Luther King Assistantships provide support for qualified members of minority groups. Applications should be made to the Graduate School Office.

**Summer Fellowships for Teaching Assistants:** A limited number of Summer Fellowships are available for students who have held graduate assistantships involving teaching during a previous academic year. The stipend for summer study is $900.

Approximately 360 graduate and project assistantships are awarded annually to superior students; appointments are for one academic year but may be renewable. These appointments involve half-time employment. The normal load for students holding appointments is three full courses per semester or master's thesis or doctoral research. All graduate students holding appointments as graduate or project assistants must be regularly admitted to the Graduate School and must register for two or more full courses or equivalent thesis credits or doctoral research during each semester in which they hold their appointments. Such students are considered full-time students.

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

Appointments are made in the following categories:

**Graduate Assistants:** Most assistants are involved in assisting faculty members in instructional activities. A limited number of appointments involves assisting in research activities in the Agricultural Experiment Station. Stipends for graduate assistants are $3,400 per academic year. (See Graduate Merit Scholarships program on page 21.) University supported graduate assistants receiving the full academic-year stipend may be exempted from the payment of tuition and course charges during the academic year of their appointment and the following summer session. University supported graduate assistants receiving half the normal academic-year stipend may be exempted from the payment of half of their tuition and course charges in the academic year of their appointment and the following summer session.

**Project Assistants:** These assistants aid faculty members in externally funded research projects. Stipends for project assistants are $3,400 for academic year. Doc-
Federally Funded Traineeships and Fellowships

Loan and Work-Study Programs

toral students who have held an assistantship for two years may qualify for a stipend of $3,800 per academic year. Project assistants receiving the full academic-year stipend may be exempted from the payment of tuition and course charges during the academic year of their appointment and the following summer session. Project assistants receiving half the normal academic-year stipend may be exempted from the payment of half of their course charges and academic fees in the academic year of their appointment and the following summer session. (See Graduate Merit Scholarships program on page 21.)

Graduate Associates: A very limited number of highly qualified graduate students may be appointed to teaching or research positions as graduate associates. The academic load for students appointed to these positions will not exceed two full courses or doctoral research registration per semester. Stipends are negotiable up to $5,500 per academic year according to the qualifications and duties of the student. Graduate associates receiving a stipend of more than $3,000 per academic year may be exempted from the payment of tuition and course charges during the academic year of their appointment. Graduate associates receiving $3,000 or less per academic year may be exempted from the payment of half of their tuition and course charges during the academic year of their appointment.

Summer Assistantships: Full-time summer employment may be available for project assistants or graduate assistants. The monthly rate for full-time employment is $680 for students having an academic year stipend of $3,400, and $760 for students having an academic year stipend of $3,800, for a maximum of two and a half months of full-time employment. Students so employed are not normally permitted to register for summer session courses.

Subject to the availability of federal funds, a variety of federal fellowships and traineeships are available for outstanding graduate students. These awards are open to U.S. citizens only. The stipends for these awards vary somewhat but average $3,900 for 12 months of study plus tuition waiver.

It is suggested that applicants contact the National Science Foundation, Fellowship Office, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418 and/or Career Development Review Branch, Division of Research Grant, National Institutes of Health, Public Health Service, Bethesda, Maryland 20014.

National Direct Student Loans: To be eligible for consideration, a student must be an admitted degree candidate carrying at least one-half the full-time academic load as defined by the University, be a U.S. citizen or a permanent resident of the U.S., and establish need for a loan that is to be used for educational purposes only.
UNH Loans: To be eligible for consideration, a student must be a registered degree candidate. Financial need must be clearly established, and if approved, the loan may be used for educational purposes only. The maximum amount granted to a student is $1,000 during his or her undergraduate and/or graduate work.

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

Applications for the above programs may be obtained from the Financial Aid Office, Thompson Hall, and must be returned not later than May 1.

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

Academic Regulations

Graduate Credits and Grades

Credits: Graduate credits may be earned in courses numbered from 700 through 898 and in the thesis. Graduate credits will not be given for any courses which are open to freshmen and sophomores. Under certain conditions, graduate credit may be allowed for 600-level courses in master's degree programs. (See general requirements for master's degrees.)

In many departments or programs it is possible for students to do part of their work during the summer session. Students should consult the Summer Session Office in Venrette House concerning the courses offered and course schedules. Students intending to graduate in September 1979 must present dissertation or thesis to the Graduate School Office by August 10; the last day for final Ph.D. and master's examinations and completion of all degree requirements is August 17.

Grades: The following grades are used in the University: A, A-, B+, B, B-, C+, C, C-, D+, D, D-, F. Graduate credit is normally granted only for course work completed with a grade of B- or higher. Any grade below the B-level will normally not count for graduate credit and will count toward the accumulation of nine failing credits which will normally result in a student being required to withdraw from the Graduate School. However, a student's advisory committee, or adviser and appropriate departmental committee, may recommend to the dean of the Graduate
School that up to eight credits of C or C+ be granted for graduate credit. When a student’s advisory committee or his/her 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 within one month after conclusion of the course.

A Credit (Cr.) grade is given for complete, approved theses and dissertations.

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

An incomplete grade earned by a graduate student must be removed by the end of the semester following the one in which the incomplete grade was obtained. An incomplete grade automatically becomes an F if not removed within the allowed time period. It is the responsibility of the student to complete work required for the removal of the incomplete within the allotted time period. This rule does not apply to the completion of the thesis.

Academic Standards: Any graduate student receiving failing grades in 9 or more credits will be dismissed from the Graduate School. Any grade below the B- level, including grades of C or C+ which may have been approved for graduate credit, will, for the purposes of determining academic standing, be considered failing grades. Students are advised that this academic standing requirement is the minimum standard required by the Graduate School. Each individual program may set and announce standards for coursework and research achievement which are more rigorous than this minimum standard. Thus, students in some programs 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.

Transfer Credit, Master's Programs: Candidates for the master’s degree and the Certificate of Advanced Graduate Study (C.A.G.S.) may request that up to six graduate credits earned at another institution which is regionally accredited at the graduate level be transferred to count toward a master’s program. All courses presented for transfer must have been completed with a grade of B or better. The transferability of any credits will be determined by the faculty of the graduate program and the Graduate School. Students presenting credits earned in nontraditional courses and/or in courses taken at locations other than the main campus of the offering institution are advised that such courses will receive careful review to insure that they are of acceptable graduate quality. Students should also be aware that transfer credits reduce the number of credits (12) which can be earned in UNH courses taken off the Durham campus.
Transfer Credit, Doctoral Programs: Since the doctoral degree does not require a specific number of courses, credits are not formally transferred onto doctoral students’ transcripts.

General Requirements: A minimum of 30 graduate credits is required for all master’s degrees. Many programs require substantially more than the minimum 30 credits. Consult the appropriate program description in this catalog. Graduate credits are normally earned in courses numbered 700-899. Master’s candidates must earn at least eight credits in courses numbered 800-898. (Thesis credits cannot be used to meet this requirement.) Up to 12 credits earned in courses numbered 600-699 may be counted toward master’s degrees if the courses are given in a department other than the one in which the degree is earned. The faculty of each graduate program will prescribe the courses which make up the degree program. Somewhat different requirements obtain for the Master of Science for Teachers degree. Consult the appropriate program description in this catalog.

A student will normally spend at least one calendar year, or the equivalent, in satisfying the requirements for the degree. No more than 12 credits, not including thesis, may be earned in UNH courses taken off the Durham campus. Credits transferred from another graduate school will count as part of the 12 credits which may be earned off the Durham campus. Transfer and off-campus credits will be applied toward the degree only if recommended by the major department and approved by the Graduate School.

All graduate work for any master’s degree must be completed within six years of the time of registration for the first graduate work applied toward the degree. 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.

In any department or program requiring a final examination for the master’s degree, the 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 in the year in 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. Oral examining committees, when required, are appointed by the dean of the Graduate School, upon the recommendation of the department concerned. The dean of the Graduate School is, ex officio, a member of all examining committees.

Master’s Thesis: A thesis may be required of candidates for the master’s degree. Consult the individual program descriptions for thesis requirements. 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 and appointed by the dean of the Graduate School.

Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed.

From six to ten thesis credits may be applied toward a master's degree. The exact number of credits to be assigned 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. No letter grade shall be given for the thesis, but its satisfactory acceptance will be recorded with a Credit (Cr.).

Students writing theses should obtain from the Graduate School Office the latest regulations for the form and typing of theses.

Whenever a thesis is published or otherwise reproduced, it must be designated as having been accepted as a master's thesis by the University of New Hampshire.

The original and one copy of the approved thesis, ready for binding, shall be submitted to the Graduate School Office as soon after approval as possible but not less than two weeks before Commencement. Binding fees will be paid at the Graduate School. Most programs require one copy of the thesis in addition to the above-mentioned two copies. Students should consult their advisers concerning thesis requirements.

**General 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. Programs leading to the degree of Doctor of Philosophy are offered in biochemistry, botany, chemistry, economics, English, engineering, genetics, history, mathematics, mathematics education, microbiology, physics, plant science, psychology, sociology, and zoology.

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.

All graduate work for the doctorate must be completed by the end of the fifth academic year following that in which the student completes the requirements for advancement to candidacy.

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

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

After the successful completion of the qualifying examination, 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.

The student may not be advanced to candidacy for the Ph.D. until he/she has passed the qualifying examination and met such language or proficiency requirements as are deemed desirable by the faculty of the student's program and/or guidance committee. The proposed subject of the student's dissertation must be declared at the time of the advancement to candidacy.

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 from the Graduate School Office the latest regulations for the form and typing of dissertations.

A copy of the completed dissertation must be made available to the members of the examining committee two weeks before the final examination date. As soon after the examination as possible but not less than two weeks prior to Commencement, the original and one copy of the approved dissertation, ready for binding, shall be turned in to the Graduate Office. Binding, microfilming, and copyright fees will be paid at the Graduate School. Most departments require one copy of the thesis in
addition to the above-mentioned two copies. Students should consult their advisers concerning dissertation requirements.

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

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 at least two weeks prior to the date of receiving the degree. After consultation with the major department, the dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate’s performance by a majority vote.

Students admitted to the Graduate School must have their programs approved by the chairperson of the department or the chairperson of the guidance committee and by the dean of the Graduate School. Registration is held the first Monday after classes begin each semester and on the first day of the summer session. All tuition and fees are payable at the time of registration. Consult the calendar in this catalog for the date of registration.

Preregistration for continuing students is at the option of the department; students required to preregister should do so at the Registrar’s Office during the time designated in the calendar. A $10 fee is charged for not preregistering if required. Registration information and Time and Room Schedules may be obtained from the Registrar’s Office, Thompson Hall.

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.

Students who do not register during a twelve-month period and have not notified the Graduate School of their intention to continue in their degree programs must reapply for admission in order to resume their graduate work.

**Full-time Graduate Students:** Full-time graduate students are those who have received either a conditional or regular admission to the Graduate School and are enrolled each semester for sufficient course or thesis (999) credits to be liable for full tuition. Students registered for Doctoral Research (course number 999) or paying a Master’s Continuing Enrollment Charge are also classified as full-time.
students. Students holding appointments as graduate assistants or project assistants are considered full-time students and must be enrolled for a minimum of two full courses, equivalent thesis credits, or doctoral research each semester.

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

**Dropping and Adding Courses:** Graduate students may drop courses without penalty through the second Friday of classes by filing with the Registrar's Office a "drop-add" card obtained from the instructor of the course and signed by the instructor and the student's adviser. After the second Friday of classes a $10 fee is charged for each dropped course. A student may drop a course after mid-semester only for compelling nonacademic reasons, which must be presented in a petition signed by the course instructor and approved by the student's adviser and the assistant dean of the Graduate School. A course may be added through the third Friday of classes, after which a $10 fee is charged for each added course and the approval of the assistant dean of the Graduate School is necessary.

**Withdrawal Procedure:** A student may withdraw from the Graduate School during any semester by obtaining a withdrawal form from the registrar. This form should be signed by the student's adviser, the dean of the Graduate School, and other appropriate University officials (e.g., the director of residences). When completed, the form should be filed with the registrar.

If a student withdraws from a course prior to mid-semester, the course will not appear on his/her permanent record. If, for compelling nonacademic reasons, a student submits an approved petition to drop a course after mid-semester, a notation of "W" will be shown on his/her academic record together with the grade in the course at the time the course is dropped.
UNH and Graduate Life

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

The campus, 188 acres in size, is surrounded by more than 3,000 acres of fields, farms, and woodlands owned by the University. A stream flowing through a large wooded area in the middle of the campus enhances the natural open space among the buildings—35 for teaching, research, and service, and 30 residence halls for men and women.

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 Studies, Thompson School of Applied Science, Division of Continuing Education, and the Graduate School. In addition to these colleges and schools located on the University campus, the University System of New Hampshire also includes Keene State, Plymouth State, and Merrimack Valley Colleges and the School of Continuing Studies.

The University enrolls more than 10,000 students, has a full-time faculty of more than 500, and offers 89 undergraduate and 39 graduate programs. The student body includes 1,000 graduate students taught by a faculty of over 400.

The University of New Hampshire is one of 117 colleges made possible by federal land grants which aided states in developing institutions to serve all the people. The institution was founded as New Hampshire College of Agriculture and Mechanic Arts in 1866 to train young men and women for service to the state through agriculture and technology. In 1893, New Hampshire College (as it was called at that time) moved from Hanover to Durham, as the result of a bequest of lands and funds by Benjamin Thompson, and began to develop more rapidly. University status was conferred in 1923.

Graduate Student Life

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

Babcock House, the graduate student residence hall, has become a center for both academic and nonacademic graduate student activities. Events in the past year have included seminars on job opportunities, art exhibits, film series, evening gatherings, fishing trips, and trips to Boston Pops concerts. Most events at Babcock House are open to all graduate students. Graduate students are also invited to participate in most undergraduate clubs and social organizations.

Graduate students may participate in a variety of recreational, social, and cultural programs that take place on the campus throughout the year.

Each year UNH's Celebrity Series brings a colorful array of professional talent to the University. Offerings include classical, modern, baroque, and jazz music, and programs centered on human communication, whether in song, dance, speech, or mime. A sampling of recent programs includes A Funny Thing Happened on the Way to the Forum with Arnold Stang, The Tokyo String Quartet, the Milwaukee Ballet, the Royal Shakespeare Company, and the Buffalo Philharmonic Orchestra with Michael Tilson Thomas.

The Sidore Series brings provocative, well-known speakers and experimental programs throughout the year. Lorin Hollander, David Toma, Shana Alexander, and Jeremy Rifkin lectured as guests of the series in 1977-78.

University students perform frequently in concerts, recitals, and theatrical productions. These programs originate in the music and the theater and communication departments and are open to graduate students for participation. The Department of the Arts hosts exhibitions in the newly redesigned University Galleries. The University's two theaters and the art galleries are located in the Paul Creative Arts Center.

Student organizations bring folk and rock concerts to campus and provide a wide variety of social events including dances and gourmet dinners. The Memorial Union houses the student-operated FM radio station, the student newspaper, offices for student organizations, and facilities for student film services.

The Memorial Union games area runs the length of the building's lower level and contains pool tables, ping pong, pinball machines, and candlepin bowling lanes. The area is open to all; no recreation passes are required.

The Memorial Union also offers craft courses. Other student and University organizations schedule lectures, concerts, plays, or films throughout the year. There is a charge for some events but many are free.

The University Library has music listening rooms and a collection of more than 6,500 tapes and records. New Hampshire's educational television station, WENH-
Student Services

Graduate School Office

The staff of the Graduate School Office in the Horton Social Science Center is available to assist graduate students in both academic and personal matters affecting their study at the University with information and advice concerning such academic issues as admission, degree requirements, thesis and dissertation format, procedures for changing programs, interdisciplinary options, availability of fellowships and other forms of financial aid (both UNH and external), and part-time employment opportunities. The Graduate School supports graduate student organizations and assists in planning social, informational, and academic programs and events for graduate students and faculty. Students are urged to contact the office concerning any questions about the availability or applicability of various University sponsored student services to graduate students.

Babcock House: The graduate residence hall is designed to provide housing for full-time graduate students and to provide quiet, dignified areas for graduate students to meet informally with one another and with members of the faculty. Babcock House is located on McDaniel Drive within easy walking distance of a number of major classroom areas as well as the University Library, University theaters, and the Memorial Union Building. Parking is available on campus.

The structure, consisting of two six-story towers connected at each floor by a common lounge, accommodates 180 men and women. The house also has a large main lounge with fireplace, two recreation rooms, a food vending room, coin-operated laundry, TV room, luggage storage, individual mailboxes, and optional private room telephones. All rooms are single occupancy, allowing complete privacy for consultation with students or faculty. Each room is furnished with a bed, mattress, easy chair, desk chair, and built-in desk-dresser-wardrobe unit with book shelves, mirror, medicine chest, and desk lamp. Residents provide their own bedding. An optional linen service furnishes bed linen, towels, and blankets at a minimal cost.

A full-time resident director lives in the apartment on the ground floor and works in conjunction with a graduate student House Council to provide cultural and social programs for the graduate community. The resident director and four graduate resident assistants carry out the administrative responsibilities of the house and are knowledgeable about University policies and available personal services.

The rental charge for Babcock House is $900 per student per academic year. All rental fees are subject to revision by the Board of Trustees. Following acceptance
to the Graduate School, a student interested in Babcock residence must return a completed Room and Board Agreement Card with $50 prepayment to: Graduate Residence, c/o Residence Office, 7 Stoke Hall, UNH, Durham, N.H. 03824. There are usually more applicants than there are spaces available, so it is important that a student return the application and prepayment promptly. A waiting list is maintained.

**Forest Park Apartments:** The University owns and operates Forest Park, a complex of 154 studio (efficiency) and one- and two-bedroom apartments for students, faculty, and staff with families. The development is composed of two-and three-story buildings located on the edge of campus, convenient to all University facilities and within walking distance of the Durham shopping area and schools. Residency is not limited to graduate student families, and the demand for these apartments is great. To be eligible for the University apartments, a graduate student must have been admitted to the University and be a full-time student as defined in this catalog. Students may apply for Forest Park before fulfilling the above requirements as long as they are met at the time of assignment.

Since the waiting time can approach one year from date of receipt of application until assignment, students should apply as early as possible. A brochure with the application blank and information about Forest Park is available from: Forest Park Resident Manager, Building 16, Forest Park, Durham, N.H. 03824.

**Summer Housing:** A limited number of rooms in Babcock House are available to graduate students taking courses during the summer. Students interested in summer accommodations should contact the Summer Housing Office, University of New Hampshire, Durham, N.H. 03824. Summer graduate students, studying through the Division of Continuing Education, need only complete and return the Summer Housing Application Form in the DCE Summer catalog.

**Off-Campus Housing:** The Residence Office operates an office to assist students in obtaining off-campus housing. As in most university communities, rents in the Durham area can be high and the supply limited. The office does have listings of off-campus rentals in Durham and the surrounding area which are updated weekly. Students are encouraged to make every effort to come to campus so that the Off-Campus Housing Office will be able to assist in finding accommodations. The office is located near the commuter lounge of the Memorial Union Building and is open Monday through Friday.

**Dining**

Graduate students may elect to take their meals on a contractual basis with the University dining halls whether or not they live on campus. These meal tickets may be used in any of the three dining halls. There are limited cooking facilities in Babcock House but none in individual rooms.
Counseling and Health Services

**University Health Service:** This service, located in Hood House, has a well-equipped clinic for initial diagnosis and treatment of student health problems. Services include: out- and in-patient care, laboratory tests, x-rays, limited mental health care, and routine medications. For serious medical problems students are generally referred to consultants and/or a local hospital. An emergency ambulance service is available.

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

Hood House is closed during holidays and semester breaks and operates on a very limited basis during summer session. The spouses and children of students and University employees are not eligible for treatment at Hood House.

Full time graduate students using Hood House may prepay a voluntary health fee or pay a fee for services used. In addition, an optional group accident and sickness insurance policy is available through Hood House.

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

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

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

Career Planning and Placement Service

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

The service will update students' records and provide assistance to alumni.
Campus Minister and Churches

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

The Alumni Association

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

Prereq: Educ 601; Psyc 635
If permission (of the instructor, department, or a committee) is a prerequisite for all students, it is listed among the prerequisites.

Prereq: Educ 601; Psyc 635; 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.

Prereq: Educ 601; Psyc 635; /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.

Prereq: Educ 601 or permission; Psyc 635

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 course offerings for the semester.

DEPARTMENT ABBREVIATIONS
The following department abbreviations are used.

**College of Life Sciences and Agriculture**
- AnSc Animal Sciences
- Bchm Biochemistry
- Bot Botany and Plant Pathology
- Ento Entomology
- FoRs Forest Resources (NER)
- HEc Home Economics
- Hydr Hydrology (NER)
- INER Institute of Nat. & Environ. Resources (NER)
- OcEd Occupational Education
- PIsc Plant Science
- REco Resource Economics (NER)
- Soil Soil Science (NER)

**College of Engineering and Physical Sciences**
- ChE Chemical Engineering
- Chem Chemistry
- CiE Civil Engineering
- ESci Earth Science
- E E Electrical and Computer Engineering
- E T Engineering Technology
- Math Mathematics and Computer Science
- M E Mechanical Engineering
- Phys Physics
- Engr Ph.D. Engineering
- Tech Technology nondepartmental

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

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

**Separate Departments and Programs**
- Aero Aerospace Studies
- DCE Division of Continuing Education (all courses)
- Gen Genetics Program
- Inco Intercollege
- Milt Military Science
- TSAS Thompson School of Applied Science
Ancient and Modern Languages and Literatures

Chairperson: Grover E. Marshall

PROFESSORS: R. Alberto Casas; Warren H. Held, Jr.; Louis J. Hudon; Charles H. Leighton

German (Germ)

The German section of the Department of Ancient and Modern Languages and Literatures offers a program of graduate study leading to the degree of Master of Arts. This program is offered only through the German Summer School of the Atlantic, which combines the resources of UNH and the Goethe Institute of the Federal Republic of Germany. It provides students with a thorough knowledge of the German language, literature, and culture, and is designed to allow completion of the degree in a minimum of four summers.

To be admitted to graduate study, students must have completed an undergraduate program with significant concentration in German studies and have a good command of spoken and written German. They must also submit scores on the Graduate Record Examination, both the Aptitude Test and the Advanced Test in German. Students who have not had German 781, History and Development of the German Language, or its equivalent must take it before completing their graduate studies.

To satisfy the requirements for the Master of Arts degree, students must successfully complete ten full courses, including two seminars. (Courses of three or four credits count as full courses; two 2-credit courses equal a full course.) Candidates must also pass the departmental comprehensive examination based upon the master's reading list. Up to 18 credits may be taken at the University of Salzburg; interested students should consult the Director of Studies Abroad. Courses numbered 700-799 are for graduate students and advanced undergraduates. Courses numbered 800-899 are open to graduate students only. M.A. candidates must take a minimum of three courses at the 800 level.

725. HISTORY OF GERMAN-SPEAKING COUNTRIES
Survey of political, ethnological, and economic history of Germany, Austria, and Switzerland. Offered summer only. 4 cr.

726. GERMAN CULTURE AND CIVILIZATION
Historical, social, artistic, and folkloristic developments in German-speaking countries from the beginnings to the present. 4 cr.

771. INTRODUCTION TO MEDIEVAL GERMAN LITERATURE
Reading and critical analysis of selected works of the German Middle Ages. Texts in the original and in modern German translation. Offered summer only. 4 cr.

772. GERMAN LITERATURE OF THE ENLIGHTENMENT
Literature and criticism of the eighteenth century, including Gottsched, the Swiss critics, Lessing, Wieland, and the "Sturm und Drang." Offered summer only. 4 cr.

773. CLASSICAL PERIOD IN GERMAN LITERATURE
Reading and critical analysis; emphasis on Goethe and Schiller. Offered summer only. 4 cr.

774. GERMAN ROMANTICISM
Romantic movement from W. Schlegel to Eichendorff including writers outside the Romantic school, such as Kleist and Hölderlin. Offered summer only. 4 cr.

775. THE AGE OF REALISM
The outstanding prose and lyrics of Keller, Meyer, Storm, Fontane, and others. Offered summer only. 4 cr.

776. GERMAN LITERATURE FROM NATURALISM TO EXPRESSIONISM
Major literary movements 1880-1925, including Hauptmann, Wedekind, Mann, Hesse, Kafka, Rilke, and Benn. Offered summer only. 4 cr.

777. GERMAN LITERATURE FROM 1918 TO 1948
Literature of Germany between the two world wars and German exile literature. Offered summer only. 4 cr.

781. HISTORY AND DEVELOPMENT OF THE GERMAN LANGUAGE
The changes in sounds, structure, and vocabulary from the earliest record to the present. Required for German majors. 4 cr.

792. METHODS OF TEACHING GERMAN
Critical study of modern language teaching from elementary school through college; use of equipment, including films, tapes, and other audio-visual aids. Offered summer only. 4 cr.
Spanish (Span)

The Spanish section offers courses leading to two degrees in Spanish: the Master of Arts and the Master of Science for Teachers.

Master of Arts

To be admitted to graduate study for the Master of Arts degree in Spanish, a student must have completed 30 credits in Spanish language and literature beyond first year Spanish, including a survey of Spanish literature and two other literature courses. In addition, all candidates for admission must take the Graduate Record Examination Aptitude Test and Advanced Test in Spanish. To obtain the degree, the student must fulfill the course requirements, pass a comprehensive examination based on a master's degree reading list, and submit an acceptable thesis if such an option is chosen.

To satisfy the course requirements, the student must: a) successfully complete 10 graduate courses (of which eight should be from the Spanish offerings); or, b) successfully complete at least eight courses in Spanish and submit a thesis (six credits, thus completing the minimum of 30 credits required by the Graduate School). All advanced literature courses are conducted in Spanish.

In addition, M.A. students are required to take 801. Teaching assistants must also take 803. No student may register for a graduate course if s/he has already taken the corresponding undergraduate course here or its equivalent elsewhere.

A comprehensive examination based on a master's degree reading list will be given four times a year: in January, May, August, and September. The candidate will be permitted to take the examination only twice. Students failing their first attempt must wait at least three months before taking it again. The thesis option must embody the results of independent investigation and be written in a form acceptable to the Spanish section. It must be submitted to the thesis director six weeks before expected time of degree conferral.

Master of Science for Teachers

To be admitted to graduate study for the Master of Science for Teachers degree in Spanish, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in the language. To obtain the degree, s/he must complete ten graduate courses of which eight will be from among Spanish offerings. Candidates must pass a department examination based on the master's degree reading list. Secondary school teachers interested in this degree should consult the section coordinator.

801. BIBLIOGRAPHY AND METHODS OF RESEARCH
Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques and to form and style in the preparation and writing of research findings. Preparation of a research paper. 1 cr.

803. APPLIED LINGUISTICS
Required of all graduate assistants teaching in the departmental program, but open to all graduate students in Spanish. Discussion of current methodology and linguistic approaches to the teaching of Spanish. Instruction in the use of audio-visual aids including language laboratories. Readings, discussion, class observation. May be repeated for a total of 3 cr. 1 cr.

811. MEDIEVAL SPANISH LITERATURE
Spanish literature including social and historical backgrounds, 1100-1500: Poema de mio Cid, Berceo, mester de clerecia, Libro de buen amor, cancionero poets, and La Celestina. 3 cr.

831. RIVER PLATE LITERATURE
Sarmiento, Jose Hernandez, Rodó, Florencio Sánchez, Mallea. Focus on the question of Argentinidad. 3 cr. (Not offered every year.)
Animal Sciences

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. (Not offered every year.) 3 cr.

854. CERVANTES
Cervantes' 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 Blasso Ibáñez. Romanticism, realism, and naturalism. 3 cr. (Not offered every year.)

857. THEATER AND POETRY OF THE TWENTIETH CENTURY
The Generation of 1898 and Modernismo: Lorca, Casona, Buero Vallejo, Sastre, Salinas, Guillén, and Miguel Hernández. 3 cr.

858. SPANISH PROSE OF THE 20th CENTURY
Novels, short stories, and essays: Unamuno, Baroja, Menéndez Pidal, Ortega y Gasset, Julian 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. SPANISH-AMERICAN DRAMA
From pre-Hispanic origins to the present; modern playwrights of Mexico and Puerto Rico. 3 cr. (Not offered every year.)

872. SPANISH-AMERICAN NOVEL
Development from Romanticism to present; contemporary trends and techniques. 3 cr. (Not offered every year.)

873. SPANISH-AMERICAN SHORT STORY
Representative authors; stress on 20th century. Principles of interpretation. 3 cr. (Not offered every year.)

874. MAJOR SPANISH-AMERICAN AUTHORS
3 cr. (Not offered every year.)

891. METHODS OF FOREIGN LANGUAGE TEACHING—SPANISH
Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary through college. Discussion, demonstration, preparation of instructional materials, microteaching of the language skills. Prereq: permission. 3 cr.

895-896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE
A) The history of the Spanish language; B) Medieval Spanish literature; C) Spanish literature of the Renaissance; D) Spanish literature of the Golden Age; E) Spanish literature of the 18th and 19th centuries; F) Spanish literature of the 20th century (1898-1936); G) Contemporary Spanish literature; H) Spanish-American literature of the 16th and 17th centuries; I) Spanish-American literature of the 18th and 19th centuries; J) Spanish-American literature of the 20th century; K) Contemporary Spanish-American literature; L) Structural and applied linguistics; M) Spanish Literary Criticism; N) Spanish-American Essay; O) Latin America; P) Catalan; Q) Spanish-American Poetry; R) Spanish Poetry; S) Galdós; T) Archetype Latin American literature; U) Special Teaching Problems; V) Spanish Civilization and Culture; W) Latin-American Civilization and Culture; X) Borges; Y) Spanish Theater. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prereq: study of Spanish language; permission of major supervisor. Variable, 1-3 cr.

899. MASTER'S THESIS
6 cr.

Animal Sciences (AnSc)

Chairperson: W.C. Skoglund

ASSOCIATE PROFESSORS: Thomas P. Fairchild, James B. Holter, Gerald L. Smith, Larry L. Stockhouse
ASSISTANT PROFESSORS: William Condon, Walter Hylton, Frank Repka, Charles Schwab
LECTURER: Elizabeth Smith

To be admitted to graduate study in animal sciences an applicant is expected to have had sufficient undergraduate training in the basic biological sciences to qualify for special work in this field.

Students pursuing the Master of Science degree in animal sciences may select courses in genetics, nutrition, physiology, management,
and diseases and parasites. A thesis is required, and a candidate for the
master's degree shall register for six thesis credits and pass an oral ex-
amination covering the graduate courses and thesis.

Doctoral-level study in areas related to animal sciences is offered
through other biological science departments. Specifically, an inter-
disciplinary option is offered by the Departments of Biochemistry and
Animal Sciences leading to the Ph.D. degree in Biochemistry (Nutri-
tion); and the Ph.D. degree is offered in genetics through an Interde-
partmental Genetics Program (see Genetics Program in this catalog).

Opportunities are provided for students to obtain teaching as well
as research experience during their graduate studies.

701. PHYSIOLOGY OF REPRODUCTION
Physiology, embryology, endocrinology, reproduction, and lactation
in domestic animals. Mr. Condon. Lab. 4 cr.

702. EXPERIMENTAL ENDOCRINOLOGY OF REPRODUCTION AND
LACTATION
An in-depth study of the hormonal control of the estrous cycle:
pregnancy and mammary gland growth and lactation. Emphasis will
be placed on current experimental data. Mr. Condon. Lab. Prereq:
AnSc 701 and permission. 4 cr.

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

709. BIOCHEMISTRY OF NUTRITION
Intermediary metabolism of nutrients and energy; metabolism
transport mechanisms; biological oxidation; interrelationships of
carbohydrate, fat, and protein metabolism; obesity; control of
hunger and appetite. Mr. Repka. 4 cr. (Also offered as HEc 709.)

710. RUMINANT NUTRITION
Feeding and management of dairy animals; calf feeding, raising
young stock, feeding for economical milk production. Mr. Holter.
Lab. 4 cr.

711. COMPARATIVE ANIMAL GENETICS
How heredity affects domestic animals, poultry, other mammals,
and fish; emphasis on the organism and population. Quantitative in-
heritance, principles of selection, disease resistance also studied.
Statistical and experimental techniques. Lab. Prereq: 4 cr. of
genetics or permission. Mr. Collins. 4 cr.

712. ANIMAL BREEDING AND IMPROVEMENT
Population genetics and selection in dairy cattle, livestock, and
horses. Lab. Prereq: AnSc 711. Mr. Fairchild. 4 cr. (Not offered every
year.)

714. INTRODUCTION TO ELECTRON MICROSCOPY
A detailed consideration of the principles and methods used in
preparing and examining vertebrate, invertebrate, microbial, plant,
and physical specimens in the electron microscope. Topics include
the theory and application of fixation and embedding procedures,
ultramicrotomy, operation of the electron microscope, and special
techniques such as autoradiography and ultrastructural histochem-
istry. Lab. Prereq: general chemistry and permission. 4 cr.

795-796. INVESTIGATIONS IN DAIRY, LIVESTOCK, POULTRY
A) Genetics: Mr. G.L. Smith, Mr. Collins, Mr. Fairchild.
B) Nutrition: Mr. G.L. Smith, Mr. Holter, Mr. Repka, Mr. Schwab.
C) Management: Mr. G.L. Smith, Mr. Skoglund.
D) Diseases: Mr. Dunlop, Mr. Hylton, Mr. Trout, Mr. S.C. Smith,
Mr. Stackhouse.
E) Products: Mr. G.L. Smith.
F) Light Horses: Ms. Briggs, Mr. Gaiser.
G) Physiology: Mr. Condon.
The student may select a special problem in any of the fields listed
under the guidance of the instructor. Elective only after consultation
with the instructor in charge. May be repeated. 1-4 cr.

801. ADVANCED STUDIES IN ANIMAL BREEDING
Independent study and research on modern breeding methods and
newer systems of selection for quantitative traits. Prereq: AnSc 712.
Mr. Collins, Mr. Fairchild, Mr. G.L. Smith. Hours to be arranged. 3 cr.

802. MEATS, LIVESTOCK MARKETS, AND PRODUCTS
The essential factors in meat selection, cutting, curing and smoking;
study and discussion relative to the problems of livestock
marketing and the procedure in the large central markets. Trips are
taken to various packing plants. Mr. Gerald Smith. Lab. 4 cr.

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

804. PROTEIN METABOLISM AND NUTRITION
Metabolism of dietary amino acids in the mammalian system with
emphasis on various aspects of protein nutrition. Prereq: permis-
sion. Mr. Schwab. 3 cr. (Not offered every year.)

805-806. AVIAN MICROBIOLOGY
The disease process (acute or chronic) in the intact host at cellular
levels when invaded by viruses or virus-like agents, fungi, and proto-
zoans. Physiological and cytopathological changes in tissue
culture. Mr. Dunlop, Mr. Trout. 3 cr.
807-808. AVIAN HISTOPATHOLOGY
First semester: general histopathology. Second semester: the special histopathology of common diseases with emphasis on correlation of light and electron microscopy of tumors and tumor formation. Prereq: histology or the equivalent. Mr. Dunlop and Mr. Strout. 3 cr.

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

812. QUANTITATIVE GENETICS AND SELECTION
Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Prereq: 1 course each in genetics and statistics. Mr. Collins. 3 cr. (Not offered every year.)

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

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

897-898. ANIMAL SCIENCE SEMINAR
A survey of recent literature and research in the animal sciences. Staff. 1 cr. May be repeated.

899. THESIS
Hours to be arranged. 6-10 cr.

Biochemistry (Bchm)

Chairperson: James A. Stewart

PROFESSORS: Donald M. Green, Edward J. Herbst, Miyoshi Ikawa, Samuel C. Smith, Arthur E. Teeri
ASSOCIATE PROFESSORS: Gerald L. Klippenstein, James A. Stewart

For admission to graduate study in biochemistry 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.

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

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

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

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

601. GENERAL BIOCHEMISTRY
The general principles. Lab. Prereq: organic chemistry. Students receiving credit for Bchm 601 may not receive credit for Bchm 501. Mr. Ikawa. 4 cr.
656. PHYSIOLOGICAL CHEMISTRY AND NUTRITION
Mammalian biochemistry with emphasis on the human. Lab study includes procedures basic to chemical methods of medical diagnosis. Lab. Prereq: organic chemistry. Mr. Teeri. 4 cr.

702. COMPARATIVE MARINE BIOCHEMISTRY
Nutrition, metabolism, and composition of marine organisms and relation to phylogeny; marine natural products. Prereq: Bchm 601 or equivalent. Mr. Ikawa. 3 cr. (Not offered every year.)

721. NEUROCHEMISTRY
The biochemistry of the nervous system; metabolism and alterations of normal brain chemistry by drugs, chemicals, nutrition, memory, and learning; pathological changes. Prereq: biochemistry. Mr. Stewart. 3 cr. (Not offered every year.)

751-752. PRINCIPLES OF BIOCHEMISTRY
Chemistry, structure, and function of biological molecules. Metabolism and biological role of carbohydrates, lipids, amino acids, proteins, and nucleic acids. Lab. Prereq: one year of organic chemistry/or permission. Mr. Klippenstein and Mr. Stewart. 4 cr.

760. ENZYME CHEMISTRY
Structure, properties, and function of enzymes; kinetics and mechanisms of enzyme-catalyzed reactions; purification, characterization, and assay of enzymes. Mr. Klippenstein. Lab. 4 cr. (Not offered every year.)

770. BIOCHEMICAL GENETICS
The mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Lab. Prereq: Bchm 751 or permission. Mr. Green. 4 cr. (Not offered every year.)

781. THE NUCLEIC ACIDS
Chemistry and metabolism of nucleic acids; molecular structures, purification and separation, biosynthesis, and biological functions. Prereq: organic chemistry and biochemistry. Mr. Herbst. 3 cr.

795, 796. INVESTIGATIONS IN BIOCHEMISTRY
Subject matter and hours to be arranged. Prereq: permission. 2 cr.

811. BIOCHEMISTRY OF LIPIDS
The chemistry, metabolism, and function of lipids. Prereq: Bchm 752 or equivalent. Mr. Smith. 3 cr. (Not offered every year.)

832. BIOCHEMISTRY OF CARBOHYDRATES
The chemistry, metabolism, and functions of carbohydrates. Emphasis will be placed on polysaccharides, glycoproteins, and the nature of cell surfaces. Prereq: Bchm 601 or equivalent. Mr. Ikawa. 3 cr. (Not offered every year.)

842. BIOCHEMICAL REGULATORY MECHANISMS
The 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: a course in biochemistry. Mr. Stewart. 3 cr. (Not offered every year.)

850. PHYSICAL BIOCHEMISTRY
Structure, interactions, and physical properties of biomolecules. Thermodynamic, hydrodynamic, and spectroscopic methods for study of proteins and nucleic acids. Prereq: physical chemistry and biochemistry. Mr. Klippenstein. 3 cr. (Not offered every year.)

852. ADVANCED BIOCHEMISTRY LABORATORY
Techniques for purification and characterization of proteins and nucleic acids. Lab. Prereq: Bchm 751. 2 cr. (Not offered every year.)

897, 898. BIOCHEMISTRY SEMINAR
Prereq: permission. 0 cr.

899. MASTER OF SCIENCE THESIS
To be arranged. 6-10 cr.

999. DOCTORAL RESEARCH

Biology: Intercollege Biological Sciences Organization

Chairperson: Robert Blanchard
Chairperson of Graduate Advising Committee: Alan Baker

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

This is a general, nontesis program which is applicable to interests which may not be met in a formal department. Curricula may be individually designed for persons working for agencies which require advanced, broad training in the biological sciences, or for those who wish to prepare for junior or community college teaching. Applicants should have a bachelor's degree in biology, zoology, botany, microbiology, or a strong background in biological and physical sciences including physics, college mathematics, and organic chemistry. Those admitted to the program will be required to pass a final comprehensive examination on coursework taken for the degree.

Master of Science for Teachers (MST)

This is a nontesis program designed to provide experienced and/or certified secondary school teachers with an opportunity to update and expand their knowledge of biology. Applicants must have three years' experience as biology teachers, be teaching high school at the time of application, or have a valid teaching certificate for secondary school science. An applicant's teaching experience will be considered as well as undergraduate academic performance. Courses are chosen from the participating biological science disciplines in consultation with the graduate student's adviser.

Persons interested in either of these programs should contact the chairperson of the Graduate Advising Committee for further information.

Botany and Plant Pathology (Bot)

Chairperson: A. Linn Bogle

ASSOCIATE PROFESSORS: Robert O. Blanchard, A. Linn Bogle, William E. MacHardy
ADJUNCT PROFESSORS: John M. Kingsbury, Alex L. Shigo
ADJUNCT ASSISTANT PROFESSOR: Walter C. Shortle

Students admitted to graduate study in botany and plant pathology are expected to have adequate preparation in basic botany courses and in the physical sciences. All applicants must submit scores on the aptitude and advanced portions of the graduate record examination.

The candidate for the Master of Science degree will meet the Graduate School's requirements for the degree and, in addition, will be required to defend a thesis based on field or laboratory research.

A student who is working toward the Doctor of Philosophy degree will be advanced to candidacy for the Ph.D. after a successful comprehensive examination and completion of the following language requirement: a reading knowledge of at least one foreign language. The guidance committee may request a reading knowledge of two foreign languages, or a reading knowledge of one foreign language and proficiency in a cognate field such as statistics or computer techniques. The student will be required to defend a dissertation that is to be a substantial contribution to botanical knowledge.

All botany and plant pathology graduate students without professional teaching experience will satisfy the following departmental teaching requirement: each student will assist a faculty member for one semester in teaching an introductory botany course; a Ph.D. candidate will assist for one additional semester in an advanced botany course. Each student will also register for one semester of Section 9, Botanical Teaching, of either Botany 795-796 or Botany 895-896.

The department's areas for graduate study include: plant physiology, Mr. Minocha; plant ecology, Mr. Kinerson; systematic botany, Mr. Crow; phycology, marine-freshwater, Mr. Mathieson, Mr. Baker, Mr. Jahnke; plant pathology, Mr. Rich, Mr. Blanchard, Mr. MacHardy; plant morphology and anatomy, Mr. Bogle; mycology, Mr. Blanchard; cell biology, Mr. Schreiber; developmental botany, Mr. Minocha.

606. PLANT PHYSIOLOGY
Function of higher plants; water relations, metabolism, growth, and development. Prereq: elementary botany, survey of the plant kingdom, or concepts of plant growth; one year of chemistry or permission of instructor. Mr. Minocha, Mr. Pollard. 4 cr.

717. GENERAL LIMNOLOGY
Special relationships of freshwater organisms to the chemical, physical, and biological aspects of their environment; factors regulating their distribution; and the primary and secondary productivity of lakes. Individual projects. Prereq: General Ecology or equivalent. Mr. Baker, Mr. Haney. 4 cr.

719. FIELD LIMNOLOGY
Principles of freshwater ecology, from a variety of habitats; the methods used to study lakes and interpret data. Occasional Saturday field trips. Prereq: prior or simultaneous enrollment in Bot 717 and permission of instructor. Mr. Baker and Mr. Haney. 4 cr.

720. REPRODUCTIVE AND DEVELOPMENTAL PHYSIOLOGY
Recent advances in the physiology of flowering, fertilization, and seed formation; mechanisms of synthesis, transport and storage of reserve foods in seeds, tubers, etc.; role of plant hormones in agriculture; physiological aspects of plant improvement. Prereq: plant physiology or permission. Mr. Minocha. 4 cr. (Alternate years: offered 1978-79.)
721. THE MICROSCOPIC ALGAE
Survey of phytoplankton and periphyton in local marine and freshwater habitats. Identification, systematics, and evolution. Class and individual collection trips. Prereq: elementary botany, or survey of the plant kingdom. Mr. Baker. 4 cr.

722. MARINE PHYCOLOGY
The 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: elementary botany, or survey of the plant kingdom. Mr. Mathieson. (Alternate years; offered 1979-80) 4 cr.

723. MARINE ALGAL ECOLOGY
Distribution, abundance, and growth of marine plants in relation to their environment. Scheduled field trips and an independent research project are required. Prereq: Bot 722 or Zool 715 or permission of instructor. Mr. Mathieson. (Alternate years; offered 1978-79) 4 cr.

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

730. MORPHOGENESIS
Principles of differentiation; internal and external factors in cellular and organismic development. Prereq: Bot 606 or permission of instructor. Mr. Minocha. (Alternate years; offered 1979-80) 4 cr.

732. CELL BIOLOGY
Structure, behavior, and development of cells; the cellular basis of heredity. Prereq: one year of biological science and chemistry. Mr. Schreiber. 4 cr.

741. ECOSYSTEM ANALYSIS
Ecosystem structure and function; energy flow and biochemical cycles. Computer simulations of natural ecosystems. Prereq: General Ecology or permission of instructor. Mr. Kinerson. 4 cr.

742. PHYSIOLOGICAL ECOLOGY
Physiological responses of plants to the physical environment; photosynthesis, water relations, mass and energy flow. Prereq: Bot 606 or permission of instructor. Mr. Kinerson. 4 cr.

747. AQUATIC HIGHER PLANTS
Flowering plants and fern relatives found in and about bodies of water in the northeastern United States; extensive field and herbarium work, preparation techniques, and collections. Prereq: plant taxonomy. Mr. Crow. (Alternate years; offered 1978-79) 4 cr.

751. PLANT PATHOLOGY
Nature, symptomatology, etiology, and classification of plant diseases. Prereq: elementary botany or equivalent. Mr. Rich. 4 cr.

752. MYCOLOGY
Parasitic and saprophytic fungi; growth, reproduction, and identification; preparation of pure cultures. Prereq: elementary botany or equivalent. Mr. Blanchard. (Alternate years; offered 1980-81) 4 cr.

753. FOREST PATHOLOGY
Principles, etiology, epidemiology, and control of forest and shade tree diseases. Prereq: elementary botany or equivalent. Mr. Blanchard. 4 cr.

754. PRINCIPLES OF PLANT DISEASE CONTROL
Epidemiology of plant diseases and relationship to cultural practices; resistant varieties; biological control and chemical control. Crop loss assessment; disease forecasting and disease pest management. Lab. Prereq: Bot 751 or 753. Mr. MacHardy. 4 cr. (Alternate years; offered 1979-80)

761. PLANT GEOGRAPHY
The distribution of plants, a consideration of vegetation types and floras, and problems of endemism with emphasis on North America; the major influential factors such as geologic, climatic, edaphic, and biotic, including man's activities. The major contributions from Humboldt to the present time. Prereq: plant taxonomy or permission. Mr. Crow. 4 cr. (Alternate years; offered 1978-79)

762. MORPHOLOGY OF THE VASCULAR 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. Mr. Bogle. 4 cr. (Alternate years; offered 1979-80)

764. MICROTÉCNICA
Methods of preserving cell and tissue structure, embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Lab. Prereq: permission. Mr. Bogle. 4 cr. (Alternate years; offered 1978-79)
795-796. INVESTIGATIONS IN: A) SYSTEMATIC BOTANY; B) PLANT PHYSIOLOGY; C) PLANT PATHOLOGY; D) PLANT ANATOMY; E) PLANT ECOLOGY; F) MYCOLOGY; G) CELL BIOLOGY; H) PHYCOLOGY; I) BOTANICAL TEACHING; J) MORPHOLOGY; K) CELL PHYSIOLOGY; L) SCIENTIFIC WRITING
Individual projects under faculty guidance. Prereq: permission. Hours to be arr. 2-4 cr.

822. ADVANCED MARINE PHYCOLOGY
Classification, ecology, and life histories of marine algae considered at an advanced level. Seminars, discussions, assigned reading, and laboratory. Mr. Mathieson. Prereq: Bot 722 or equivalent. 4 cr.

843. THE PLANT AND THE MICROCLIMATE
Productivity, water relations, plant distribution as dependent upon soil and atmospheric physics. Laboratories provide experience with instrument design, calibration, and use for measurement of plant-environment factors. Prereq: permission. Mr. Kinerson. 4 cr. (Alternate years; offered 1978-79)

851. CELL CULTURE
Theory and principles fundamental to the culture of cells in vitro. Introduction to techniques of preparing and maintaining animal, plant, insect, and fish cell cultures. Application of cell culture to contemporary research in the biological sciences. Mr. Strout and staff, Mr. Metcalf, and Mr. Minocha. Prereq: permission. 4 cr. (Also offered as Micr 851 and AnSc 851)

852. METHODS IN MYCOLOGY
Laboratory procedures employed in various aspects of mycological research from selection of research problem to journal publication. Prereq: Bot 752 or permission. Mr. Blanchard. 4 cr. (Alternate years; offered 1979-80)

853. ADVANCED PLANT PATHOLOGY
Advanced theories and methods in plant pathology; plant pathogenesis; host/pathogen interactions. Prereq: Bot 751 or 753; permission. Mr. MacHardy. 4 cr. (Alternate years; offered 1978-79)

858. PLANT ANATOMY
Anatomy of vascular plants; structure and development of basic cell and tissue types and of major organs of woody plants. Term project and final report. Prereq: introductory botany or survey of the plant kingdom; permission. Mr. Bogle. 4 cr. (Alternate years; offered 1978-79)

867. ADVANCED SYSTEMATIC BOTANY
Principles and rules of plant classification and nomenclature; plant families; field and herbarium work. Prereq: plant taxonomy. Mr. Crow. 4 cr. (Alternate years; offered 1979-80)

899. MASTER OF SCIENCE THESIS
Six credits required. Variable 6-10 cr.

999. DOCTORAL DISSERTATION

Business Administration (Admn)

Director of M.B.A. Programs: Allan R. Cohen


ASSISTANT PROFESSORS: Marc Herold, Eric Orkin, Gordon D. Smith
INSTRUCTORS: Michael Kole, Michael Merenda, Dean Plager, Starr Schlobohm

The Whittemore School offers a program leading to the M.B.A. in formats designed for day students, evening students, and practicing executives. The program is designed to prepare graduates for professional careers in administration in both profit and not-for-profit organizations in a rapidly changing world. The M.B.A. program is directed toward a broad preparation in general administration through the study of: 1) the increasing body of relevant knowledge drawn from the behavioral sciences, mathematics, and economics; 2) the existing and emerging processes and institutions of the functional fields of administration; and 3) the role of business and other organizations in a complex and turbulent society.

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

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

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

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

The Whittemore School curriculum for day students consists of an integrated sequence of 18 courses requiring two years of study which can be started only in the fall semester. During the first year, 11 required courses or part courses in the basic disciplines (quantitative analysis, economics, and behavioral science) and the functional areas of management (accounting, marketing, operations management, and financial management) are integrated into an overall study of the process of administration. Special attention is also given to the study of the modern corporation as an economic, legal, and social organization by requiring all students to complete the course, The Organization and Its Environment.

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

Evening students complete 18 courses offered two evenings per week for three years. The evening program may normally be started only in the fall term and, because of the cumulative nature of the program, students should expect to stay on schedule with their class. The program is designed for the nonbusiness undergraduate and is aimed at broad training rather than intensive specialization. It is comparable to the day M.B.A. curriculum but tailored to the content and scheduling needs of people working full-time in the Durham area.

The curriculum for practicing executives contains the same course requirements as the day and evening M.B.A. programs but is tailored to the content and scheduling needs of those working full-time at executive-level jobs. The program is offered on site in the Digital Equipment plant in Merrimack, N.H. Classes are scheduled on evenings and weekends.

**Required Business Administration Courses:** (day and evening M.B.A. candidates): 801, 803, 804, 806, 808, 810, 811, 815, 816, 817, 818, and 820.

Further information on both the day and evening M.B.A. programs can be obtained by writing to the assistant dean, Whittemore School of Business and Economics, University of New Hampshire, Durham, New Hampshire 03824.

**702. APPLIED STATISTICS**
Time series and cross-sectioned data; regression analysis; computerized statistical packages. Experimental design; surveys; contingency analysis. Prereq: Admn 801 or basic statistics; permission. 4 cr.

**705. OPERATIONS RESEARCH**
Synthesis and analysis of basic principles and methods of operations research applied to managerial decisions. Mathematical programming, networks, inventory, queuing, sequencing, scheduling, and Markovian models. Prereq: permission. 4 cr.

**706. ADVANCED OPERATIONS RESEARCH**
Analysis and synthesis of complex operations research models. Project is undertaken by all students. Advanced mathematical programming (nonlinear, parametric linear, stochastic, and dynamic), stochastic inventory models, advanced queuing models, and heuristic programs. Prereq: Admn 705 or permission. 4 cr.

**708. MODELLING AND SIMULATION**
Modelling: formulation, data preparation, translation, validation, interpretation, and implementation. Discrete simulation models are developed and applied using a special purpose simulation language. Prereq: Admn 801 and 810 or basic probability and statistics; permission. 4 cr.
712. ORGANIZATIONAL CHANGE
Process of change in organizations. Change strategies; role of the change agent and his/her relation to the client system. Bases of resistance to change and problems encountered by internal and external change agents. Theoretical reading material, cases, and exercises. Prereq: permission. 4 cr.

713. INTERPERSONAL AND GROUP DYNAMICS
Dynamics of small groups through the use of the class itself as an intensive laboratory study group. Students examine their own behavior and its effects on others through the use of the Laboratory Training Group (T-group), and develop conceptual ability and behavioral skills. Readings in group dynamics, interpersonal relations, and sensitivity training. Prereq: permission. Lab fee. 4 cr.

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

715. THEORY AND PRACTICE OF GROUP LEADERSHIP
Comparison of and practice in leading task- and process-oriented groups. Student teams design presentations on leadership topics, then study their own leadership-membership issues. Each student also participates in and leads a process-oriented group. Prereq: Admn 713 or equivalent; permission. 4 cr.

717. ADVANCED FINANCIAL ACCOUNTING
Theory and practice as they contribute to the significance and limitations of the financial statements. Prereq: permission. 4 cr.

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

720. AUDITING
The independent auditor and his/her attest function in society. Professional ethics and responsibility. Audit concepts, procedures, objectives, and reports. Operational audits, social audits, and management services. Prereq: Admn 717 or permission. 4 cr.

722. ACCOUNTING SEMINAR
Special topics. Prereq: Admn 717 or 718, depending on topics; permission. 4 cr.

728. STATISTICAL DECISION MAKING
Probability and statistics applied to decision problems. Bayesian approach to decisions under uncertainty, which explicitly injects prior judgments of decision makers and the consequences of alternative actions. Prereq: Admn 424 or equivalent. 4 cr.

730. INVESTMENTS ANALYSIS

732. EXPLORATIONS IN ENTREPRENEURIAL MANAGEMENT
Past and probable future role of the entrepreneur in the economic and social development of the U.S. Differences between entrepreneurial and administrative management. Mythology of the “American Dream,” entrepreneur as a change agent, entrepreneurial motivation and behavior patterns, venture-capital markets, and role of the entrepreneur in nonprofit institutions. Prereq: permission. 4 cr.

741. TRANSPORTATION
Problems of American transportation system. Economic structure of transportation industries; competition among the several modes. Public policy questions: merger, cost-benefit analysis of facilities, for example. Freight transportation; problems of passenger transportation, especially in urban areas. Prereq: permission. 4 cr.

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

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

747. FEDERAL TAXATION
Current federal income, estate, and gift taxes and their impact on corporations, partnerships, and individuals. Tax analysis and decision making. 4 cr,
750. MARKETING MANAGEMENT
Practical application of theories taught in marketing. Planning, organization, and control of marketing activities in large corporations and small businesses; new product development; pricing policies; selection of channels of distribution; interrelationships between marketing, production, and finance. Sound policy formulation and decision making established through analysis of cases and computer simulation. Prereq: a basic marketing course. 4 cr.

751. ADVERTISING AND PROMOTION
Advertising, personal selling, and other promotional tools to help solve marketing problems; advertising as a medium of communications and as a social cultural force in the Western world. Prereq: Admn 651, 808, or permission. 4 cr.

752. MARKETING RESEARCH
Identification, collection, and analysis of data for the marketing process. Strengths, limitations, environment, and evaluation of research in the marketing process. Prereq: quantitative analysis and marketing or their equivalent. 4 cr.

755. ADVANCED BUSINESS FINANCE
Development of analytical tools and practical skills for recognizing and solving complex problems of business finance. Working-capital management, capital budgeting, cost of capital, capital structure, and dividend policy. Prereq: financial management. 4 cr.

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

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

762. 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 alternate solutions, and submit a recommended course of action. Prereq: Admn 651 or Admn 808; one additional advanced marketing course; permission. 4 cr.

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

780. WOMEN IN MANAGEMENT
Issues faced by women managers in complex organizations; problems associated with role expectations of women as they move into managerial positions traditionally filled by men. Prereq: senior or graduate standing. 4 cr.

795. INTERNSHIP
On-the-job skill development through fieldwork in an organization (business, industry, health, public service, etc.). Normally, supervision provided by qualified individual in the organization, with frequent consultation by a faculty sponsor. Written report required. Internships may be part- or full-time, with course credits assigned accordingly. Variable 1-16 cr.

798. SEMINAR IN ADMINISTRATION
Special topics: may be repeated. Prereq: consent of adviser and instructor. Variable 1-4 cr.

801. QUANTITATIVE METHODS
Basic mathematical and statistical concepts applied to managerial decision making. Probability, statistics, decision trees, and mathematic models. 4 cr.

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

804. MANAGEMENT ORGANIZATION
Theories of organization and analysis of contemporary forms and structure. Concern is with development of rational management processes in a dynamic society. 2 cr.

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

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

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

811. THE ORGANIZATION AND ITS ENVIRONMENT
Study of the modern corporation as a partly economic, legal, and social organization, including examination of widely held views of business and views of businessmen about themselves. 3 cr.

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

816. BUDGETING AND CONTROL
Introduction to various models employed by organizations in the financial planning and control processes. 2 cr.

817. BUSINESS CONDITIONS AND ECONOMIC FORECASTING
Managerial effects of historical and forecasted movements in interest rates, national income, inflation, and unemployment. 3 cr.

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

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

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

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

861. THE PHILOSOPHY OF MANAGEMENT SCIENCE
Study of management from a systems-analysis point of view. 4 cr.

895. SPECIAL PROJECTS AND INDEPENDENT STUDY
Projects, research, and reading programs in areas required for concentration. Sixty days' advance approval of the student's plan of study by adviser and by proposed instructor required. Staff. Variable cr. (May be repeated.)

Chemical Engineering (Ch E)

Chairperson: Stephen S.T. Fan

PROFESSOR: Stephen S.T. Fan
ASSOCIATE PROFESSOR: Gail D. Ulrich
ASSISTANT PROFESSORS: Ihab H. Farag, Virendra K. Mathur

To be admitted to graduate study in chemical engineering, an applicant is expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

A minimum of 30 credits, which must include Ch E 813, 815, 816, and 823, is required for the Master of Science in Chemical Engineering degree. The core-courses requirement can be waived only in special cases with permission from the department faculty. A candidate for the Master of Science degree must prepare a thesis, for which up to six credits will be allowed, unless the candidate is specifically exempted by the faculty because of previous research experience.

For students who are interested in graduate studies beyond the Master of Science degree, an interdepartmental Engineering Doctor of Philosophy program is available which includes the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. For details refer to the section entitled Engineering Ph.D. Program on page 82.

Courses numbered between 600 and 699 may be taken for graduate credit by nonmajors only.

Permission of the instructor and consent of the student's adviser are required for enrollment in all chemical engineering courses.
701. HIGH POLYMERS
Principles and practice of industrial methods of polymerization and processing. Physical and chemical testing of various polymers. 4 cr.

705. 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. 4 cr.

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

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

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

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

804. RADIATIVE HEAT TRANSFER
Heat transmission in high temperature operations and interaction of radiative and other transport mechanisms; radiation geometry; application of matrix algebra to radiative transfer in enclosures; zoning methods of temperature measurements. Analytical and empirical approximations of engineering use. Quantitative design of several furnaces and high-temperature systems. 3 cr.

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

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

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

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

832. 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.

852. ADVANCED PROCESS DYNAMICS
Process dynamics for higher order processes and nonlinear processes. Modeling of complex process by differential equations, linearizing nonlinear elements, and adequately controlling the entire system. 3 cr. (Not offered every year.)

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

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

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

899. MASTER'S THESIS
Original investigations in chemical engineering. 1-6 cr.
Chemistry (Chem)

Chairperson: C.L. Grant

ASSOCIATE PROFESSORS: N. Dennis Chasteen, Colin D. Hubbard, Charles W. Owens
ASSISTANT PROFESSORS: W. Rudolf Seitz, Gary R. Weisman
GRADUATE COORDINATOR: Frank L. Pilar

The Department of Chemistry offers programs leading to three graduate degrees: Doctor of Philosophy, Master of Science, and Master of Science for Teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting each new student's graduate work at the proper level. These examinations will be offered at the beginning of the semester in September and in February.

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

Doctor of Philosophy Degree

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

The Ph.D. candidate will be expected to demonstrate proficiency in reading chemical literature in German and French or Russian. He/she will also demonstrate to the doctoral committee that he/she has a broad basic knowledge of the field of chemistry: 1) by completing certain fundamental graduate courses; and 2) by means of a series of examinations in the major field. The principal emphasis of the last two years will be on the research project that will constitute the dissertation. During this time the doctoral candidate will present and defend an original research proposal before the doctoral committee.

Master of Science Degree

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

Master of Science for Teachers Degree

This program is offered for candidates who hold a secondary-school teacher certification in chemistry. This degree requires 30 semester hours in courses approved by the graduate coordinator. Persons interested in this degree should confer with the graduate coordinator.

Interdisciplinary Programs in Chemistry

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

Analytical Chemistry

762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS
Theory, instrumentation, and application of instrumental methods of analysis including electrochemistry, spectroscopy, and chromatography. Prereq: Quantitative Analysis; Physical Chemistry II pre-or coreq or permission. Students must register for Chem 763 concurrently. 3 cr.

763. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LABORATORY
Experimental parameters, error analysis, and applications of the methods covered in Chem 762. Must be taken concurrently with Chem 762. Lab. 2 cr.

830. ADVANCED OPTICAL METHODS
Techniques of chemical identification and analysis utilizing optical instrumentation from the standpoint of both theory and application. Topics include NMR, ESR, x-ray fluorescence, mass spectrometry, electron beam microprobe. 3 cr. (Not offered every year.)

831. ADVANCED ELECTRICAL METHODS
Introductory electronics for chemists; theory and applications of important electrochemical techniques such as polarography and cyclic voltammetry. 3 cr. (Not offered every year.)
833. CHEMICAL SEPARATIONS
The use of various separation techniques prior to analysis, and separations as a method of analysis are discussed. 3 cr. (Not offered every year.)

Inorganic Chemistry

774. INORGANIC CHEMISTRY
Basic theoretical concepts and their applications to inorganic reactions and compounds. Prereq: Chem 683; Chem 684 pre- or corequisite/or permission. Undergraduates must take Chem 774 concurrently. 3 cr.

775. INORGANIC CHEMISTRY LABORATORY
Synthesis and characterization of inorganic compounds with an emphasis on techniques not taught in other laboratory courses. Undergraduates must take Chem 774 concurrently. Lab. 2 cr.

803. ADVANCED INORGANIC CHEMISTRY I
Survey of some concepts of modern inorganic chemistry, serving as general background material for all graduate students and as basic fundamentals for further courses in inorganic chemistry: periodicity, stereochemistry and bonding in inorganic compounds, the crystalline state, reactions in solution, energetics, and elementary coordination chemistry. 4 cr.

804. ADVANCED INORGANIC CHEMISTRY II
Specialized topics for the advanced student. Topics may include advanced discussions of topics in Chem 803, inorganic reaction mechanisms, nonaqueous solvent systems, fluorine chemistry, bioinorganic chemistry, solid state chemistry. 3 cr.

847. ADVANCED INORGANIC CHEMISTRY III
Modern theory applied to spectra, magnetism, kinetics, and thermodynamics of coordination compounds. The formation of and reactions of coordination compounds including catalytic reactions. Prereq: Chem 803 or permission. 3 cr. (Not offered every year.)

848. ADVANCED INORGANIC CHEMISTRY IV
The theory and practice of x-ray diffraction and the determination of crystal structure. Prereq: Chem 803 or permission of instructor. 3 cr. (Not offered every year.)

Organic Chemistry

651-652. ORGANIC CHEMISTRY
Principal classes of organic compounds, aliphatic and aromatic, with emphasis on reactions, mechanisms, and structural theory. Prereq: Chem 404, Introductory Chemistry, or permission. Must be taken concurrently with Chem 653-654. 3 cr.

653-654. ORGANIC CHEMISTRY LABORATORY
Laboratory exercise to accompany Chem 651-652. Must be taken concurrently with Chem 651-652. 2 cr.

755. ADVANCED ORGANIC CHEMISTRY
Advanced stereochemistry, mechanisms and synthetic reactions; structure determinations and synthesis of complex molecules. Prereq: organic chemistry or permission. Undergraduate students must register for Chem 756 concurrently. 3 cr.

756. ADVANCED ORGANIC CHEMISTRY LABORATORY
Modern synthetic and analytical procedures. Must be taken concurrently with Chem 755. 2 cr.

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

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

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

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

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

Physical Chemistry

663. INTRODUCTORY RADIOCHEMICAL TECHNIQUES
Radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilize radiochemical operations. Lab. Prereq: general inorganic chemistry and general physics. 4 cr.
683-684. ELEMENTARY PHYSICAL CHEMISTRY
The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance, and electromotive force. Prereq: Calculus II and physics. Undergraduates must register for Chem 685-686 concurrently. 3 cr.

685-686. PHYSICAL CHEMISTRY LABORATORY
Experimental work illustrating the principles of chemistry. Emphasis is upon the measurement of thermodynamic properties, chemical kinetics, and methods of determining the structure of matter. Lab. Prereq: Calculus II and physics. Must be taken concurrently with Chem 683-684. 2 cr.

776. ADVANCED PHYSICAL CHEMISTRY

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

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

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

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

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

826. NUCLEAR AND RADIOCHEMISTRY
Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. 3 cr.

827, 828. THEORETICAL CHEMISTRY I, II
The modern concepts and mathematical formalism of quantum mechanics and applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. 3 cr.

829. THEORETICAL CHEMISTRY III
Statistical mechanics with applications to thermodynamics of nonideal systems, intermolecular forces, and chemical kinetics. Prereq: permission. 3 cr.

General Offerings
Courses in which all areas of specialization participate.

708. RESEARCH TECHNIQUES
Lectures and laboratory to show experimental methods and interpretation of results. Topics include chromatography, data handling, nuclear magnetic resonance, mass spectrometry, elementary electronics, infrared and ultraviolet spectroscopy, and x-ray. 1-3 cr.

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

895, 896. COLLOQUIUM IN CHEMISTRY: A) INORGANIC CHEMISTRY; B) ORGANIC CHEMISTRY; C) THEORETICAL ORGANIC CHEMISTRY; D) PHYSICAL CHEMISTRY; E) ANALYTICAL CHEMISTRY
1-4 cr. Sections of the course may be taken to a total of 12 cr.

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

899. THESIS—PROBLEMS IN CHEMISTRY
Conferences, library, and experimental work in some field of chemistry. Cr. to be arranged.

999 DOCTORAL RESEARCH
Civil Engineering (Ci E)

Chairperson: Paul L. Bishop

PROFESSOR: Tung-Ming Wang
ASSOCIATE PROFESSORS: Paul L. Bishop, Louis H. Klotz, Paul J. Ossenbruggen
ADJUNCT ASSOCIATE PROFESSOR: Gerald H. Batchelder
ADJUNCT ASSISTANT PROFESSOR: Robert G. Moynihan
GRADUATE COORDINATOR: Tung-Ming Wang

The Department of Civil Engineering offers the master's degree in Civil Engineering with the following areas of specialization: Environmental Engineering, Ocean and Coastal Engineering, Soils and Materials Engineering, and Structural Engineering.

A candidate for the degree of Master of Science in Civil Engineering must have completed a baccalaureate degree in engineering, mathematics, or science. If the undergraduate work is deficient, the candidate may be required to take undergraduate courses without graduate credit in order to present the proper prerequisites for graduate courses in the area of a major and minor interest. In addition, other undergraduate courses may be required by the student's adviser in order to achieve an integrated program.

The candidate for the master's degree may elect Plan A or Plan B program. The Plan A program requires a minimum of 24 credits of graduate-level course work plus a thesis for which six graduate credits are normally awarded. In the case of highly original and unusual work, a maximum of nine credit hours may be awarded for the thesis. The Plan B requires a minimum of 30 hours of graduate-level course work plus a written paper, which is to be written in one of the project courses not included in the 30 credit minimum. The Plan B paper is equivalent to a thesis in style and quality, but not in scope. One bound copy of the thesis or Plan B paper is required by the department for its files. Additional bound copies are usually presented to the library and the candidate's adviser.

All candidates for the master's degree are required to take a final oral examination. The examination committee, appointed by the dean of the Graduate School from nominations by the department chairperson, will consist of at least two senior faculty members from within the civil engineering department and an additional senior faculty member usually selected from another department within the College of Engineering and Physical Sciences. The oral final examination will consist of a defense of the thesis or Plan B paper as well as an examination of the engineering fundamentals leading to the master's degree. The thesis or Plan B paper should be given to the committee members at least two weeks prior to the date of the final oral examination.

The master's programs in civil engineering are becoming increasingly interdisciplinary. Candidates may be required to complete graduate-level courses in other departments in order to enlarge their educational experience and to acquire fundamental skills expected of a master's candidate.

Ph.D. programs are available through the Engineering Ph.D. Program. Selected candidates work within one of four established areas of specialization. Most Ph.D. candidates with civil engineering backgrounds would work either in the theoretical and applied mechanics or the engineering systems design program areas. All interested candidates are advised to consult the graduate coordinator for the details of these programs. Additional information about the Engineering Ph.D. Program is presented in the Engineering Ph.D. section of this catalog.

Courses numbered above 700 may be offered biennially or upon demand. Courses numbered between 600 and 699 may be taken for graduate credit only by nonmajors. Permission of the instructor and consent of the adviser are required for enrollment in all civil engineering graduate courses. With the approval of the department chairperson and graduate dean, six graduate credits taken at other institutions prior to admission to the University of New Hampshire Graduate School may be applied to the master's degree. Senior undergraduates interested in the dual bachelor's and master's degree programs should consult the appropriate section of this catalog under "Graduate Credits."

Areas of Interest

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

Environmental Engineering Areas of interest include water and wastewater treatment; treatment of industrial wastes such as those from tanneries, paper mills, metal finishers, and lithographers; formation and control of trihalomethanes in drinking water; dynamic control of the coagulation process in water treatment; and kinetics of algal growth and nutrient uptake.

Ocean and Coastal Engineering Areas of research include the design and analysis of offshore structures, soil-foundation interaction of offshore structures, estuarine circulation, sediment transport processes, and dynamic responses of coastal and ocean structures.

Soils and Materials Engineering Topics of interest include fabric identification in sands by acoustic methods, instability of offshore slopes,
influence of pore size and pore-size distribution on frost heaving of granular materials, influence of aggregate gradation on controlling the water cement ratio of portland cement concrete while maintaining workability, and internally sealed concrete.

Structural Engineering Research topics include coupled, twisting-bending vibrations of continuous curved beams; effects of rotatory inertia and shear on multispan curved frames; vibrations of cable-stayed structures; computer-aided structural planning and design of buildings; soil-structure interactions; and design investigations for the reconstruction of small/low-head, hydro-power facilities.

701. ADVANCED SURVEYING
Instrumental and analytical photogrammetry. Conformal mapping and its application to the state plan coordinate systems. Geodetic surveying. Error theory and its application to the planning and adjustment of surveys. Application of electronic computers to surveying calculations. Prereq: Surveying. 4 cr.

711. COMMUNITY PLANNING
A student project course that focuses upon an authentic problem facing a community. Investigation of present and future issues, such as, population growth, community needs, economic and legal problems, will be conducted. The use of land use models, survey techniques and economic evaluation methods will be utilized. Oral and written reports are required. Prereq: normally senior standing and permission. A year-long course; 2 credits each semester, 4 credits total, an "IA" grade (continuous course) will be given at the end of the first semester.

714. CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS
Essential elements and legal requirements of engineering contracts; purposes and content of specifications; professional conduct, relations, registration, and ethics. Construction planning and management; cost analysis based on quantity surveys and unit-cost methods. Prereq: permission of instructor. 3 cr.

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

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

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

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

740. RURAL WASTEWATER ENGINEERING
Methods for collecting and treating wastewater in small communities and rural areas. Biological and physicochemical treatment systems for small communities; land application; soil absorption; grey water treatment; and septic tank treatment. Prereq: permission. 3 cr.

741. OPEN CHANNEL FLOW
Energy and momentum principles in open channel flow; flow resistance; channel controls and transitions; unsteady open channel flows; convective and dispersive transportation of pollutants; and basic modeling techniques. Prereq: Fluid Mechanics. 3 cr.

743. ENVIRONMENTAL SAMPLING AND ANALYSIS
Laboratory exercises in the techniques of water, wastewater, and solid-waste sampling and analysis. Interpretation of results from pollution surveys and operation of pollution control facilities; statistics of sampling and statistical evaluation of analytical data. Prereq: Introduction to Environmental Pollution Control or permission. 2 cr.

745. HYDROLOGY AND HYDRAULICS
Occurrence and physical effects of water on the earth; meteorology, groundwater runoff and stream-flow routing, open-channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. Prereq: Fluid Mechanics. 4 cr.
746. **WASTEWATER TREATMENT PLANT DESIGN**
Choice of treatment units. Design of the components; preparation of a plan for a particular city that includes a suitable combination of the units previously designed. Prereq: Water and Wastewater Engineering. 3 cr.

748. **SOLID WASTE DISPOSAL**
Basic concepts and theory of collection and disposal systems. Design methods involved in disposal systems. Prereq: Introduction to Environmental Pollution Control or permission. 3 cr.

749. **CHEMISTRY OF NATURAL WATERS**

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

752. **TRAFFIC ENGINEERING**
Statistical and probabilistic methods to analyze and design roadway facilities. Level of service and capacity analysis of roadways under uninterrupted and interrupted flow conditions. Queuing theory, simulation models, design of traffic facilities. Prereq: Probability and/or Statistics. 3 cr.

757. **COASTAL ENGINEERING AND PROCESSES**
Small amplitude and finite amplitude wave theories; wave forecasting by significant-wave and wave-spectrum methods; coastal processes and shoreline protection; wave forces and wave structure interaction; coastal and estuarine pollution control and analysis; mathematical and physical modeling. Prereq: Fluid Mechanics or permission. 4 cr.

763. **ADVANCED SOIL MECHANICS I**
The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. Prereq: permission. 4 cr.

765. **FOUNDATION ENGINEERING**
Application of the principles of soil mechanics to selection of the type of substructure; determination of allowable soil-bearing capacities based on rupture and settlement theories; determination of active and passive earth pressures; and foundation construction methods. Prereq: Soil Mechanics; Structural Design Concepts; senior standing. 4 cr.

768. **SEEPA GE THROUGH EARTH STRUCTURES**
Groundwater flow, Darcy's law, flow nets, Deupit's theory and application, conformal mapping techniques, confined flow, flow through earth and rock structures, seepage towards wells. Prereq: Fluid Mechanics; Soil Mechanics. 2 cr.

782. **TIMBER DESIGN**
Properties and characteristics of structural woods, mechanics of wood, connection methods, design of timber members, and connections in beams, columns, and trusses, and glued laminates of wood. Prereq: Structural Design Concepts; permission. 2 cr.

784. **STRUCTURAL ANALYSIS BY MATRIX AND NUMERICAL METHODS**
Unifying concept of basic structural analysis theories; matrix and numerical methods of analysis, and their application by linear graph concepts using computers. Prereq: Indeterminate Structures. 4 cr.

785. **INTRODUCTION TO STRUCTURAL DYNAMICS**

790. **INELASTIC STRUCTURAL DESIGN**
A continuation of modern design theory; ultimate design of reinforced concrete; plastic analysis of steel structures. 4 cr.

793, 794. **ADVANCED STRUCTURAL DESIGN I AND II**
Design in steel by elastic and plastic theories and in reinforced concrete by the working stress and ultimate strength methods for structural elements and connections using the appropriate controlling specifications. Prereq: Structural Design Concepts or permission. 4 cr.

795, 796. **INDEPENDENT STUDY**
A limited number of qualified senior and graduate students will be permitted to pursue independent studies under faculty guidance. Seniors may write terminal theses reporting the results of their investigation. 2-4 cr.
800. **CIVIL ENGINEERING SEMINAR**
Topics of interest to graduate students and staff; reports of research ideas, progress, and results; invited lectures by outside speakers. 0 cr.

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

855. **MICROBIOLOGY OF WASTEWATER TREATMENT**
Detailed study of the microbiological aspects of wastewater treatment and the techniques used in the biological testing of water and wastewater. Lab. Prereq: Water and Wastewater Engineering; General Microbiology/or permission. 4 cr.

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

857. **ADVANCED WASTEWATER TREATMENT**
Theory, application, and evaluation of new processes and developing techniques in water and wastewater reclamation and reuse. Prereq: Ci E 746. 4 cr.

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

864. **ADVANCED SOIL MECHANICS II**
The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. Prereq: permission. 4 cr.

865. **SOILS ENGINEERING**
Application of soil-mechanics' principles to the selection of the type of substructure and the development of its bearing capacity, based on the theories of stability analysis and consolidation. Earth-pressure load determinations by various active and passive earth-pressure theories. Earth dam and foundation construction methods. Prereq: Ci E 763 or equivalent. 4 cr.

866. **SOIL TESTING FOR ENGINEERING PURPOSES**
The essential tests for the physical properties: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. Prereq: Ci E 763 or equivalent. 2-4 cr.

867. **SOIL DYNAMICS**
Vibrations of elementary systems, wave propagation, elastic waves in layered systems, behavior of dynamically loaded soils, vibrations of foundations, isolation of footings, field measurements and instrumentation, design procedures for dynamically loaded foundation. Prereq: Ci E 765; Ci E 763. 2 cr.

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

882. **ADVANCED STRUCTURAL ANALYSIS II**
Advanced treatment, including flexible and axially loaded flexural members, beams with variable cross-section subject to axial loads, suspension bridges and flexible arches, and torsional problems of noncircular sections. 4 cr.

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

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

885. **APPLICATION OF SYSTEM THEORY TO STRUCTURAL ANALYSIS**
Comprehensive development of the stiffness matrix of structures. Intuitive concepts of topology and linear graphs and their application to structural frameworks. Analysis of structures using linear graphs. 4 cr.
886. FACILITY PROJECT ENGINEERING
   A critical review of the approaches to the planning and decision processes of facilities, including codes and specifications, concepts of engineering economy, index numbers and cost estimation procedures (including an introduction to their statistical basis), mathematical modeling concepts, and the development of design loads and criteria for specific application. 4 cr.

887. APPLICATION OF LINEAR GRAPHS TO CIVIL ENGINEERING
   Concepts of topology and linear graphs and their application to civil engineering planning of transportation, water and sewage distribution, and other networks. Network planning and management systems, including Project Evaluation Review Technique (PERT), Critical Path Methods (CPM), and PERT/cost procedures. 4 cr.

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

895, 896, 897. CIVIL ENGINEERING PROBLEMS
   The study and investigation of problems selected to meet the needs of the students. 2-4 cr.

899. MASTER'S THESIS
   Variable 6-9 cr.

Earth Sciences (ESci)

Chairperson: Herbert Tischler

PROFESSORS: Cecil J. Schneer, Herbert Tischler
ASSISTANT PROFESSORS: Wendell S. Brown, Theodore C. Loder, Paul A. Mayewski
ADJUNCT PROFESSOR: Robert I. Davis
COORDINATOR OF GRADUATE PROGRAM: Franz E. Anderson

The Department of Earth Sciences offers graduate work leading to the Master of Science in Earth Sciences with options in either geology or oceanography.

Admission Requirements
   1) Students are expected to have completed at least a year of college chemistry, physics, and calculus;
   2) Students with an undergraduate equivalent to a major in geology, chemistry, physics, mathematics, engineering, or in the biological sciences will be considered;
   3) All applicants must submit scores on the aptitude portion 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 option (geology or oceanography) a student wishes to follow will determine the level of necessary preparation. For instance, a student with an undergraduate major in physics who wishes to change direction to marine geology would have a number of deficiencies in geology to complete beside completing the core curriculum in oceanography. However, if that student wished to pursue a program stressing physical oceanography, fewer deficiencies would probably have to be completed. The preparation of each student will be determined prior to the beginning of the first semester in residence in order to plan the course of study.

Degree Requirements

   General Minimum Requirement: In addition to any deficiencies, students must satisfactorily complete a minimum of 30 credits of which 8 (not including 899) must be taken at the 800 level, and complete a thesis.

   Geology Option Requirements: This option is designed primarily for students with an undergraduate background in geology. Emphasis in this option may be placed upon: Petrology-Mineralogy-High Temperature Geochemistry; Geomorphology-Glacial Geology; Geophysics; Sedimentation-Low Temperature Geochemistry; Stratigraphy-Paleontology.

   The option in geology normally includes:
   1) The core curriculum (total of 22 cr.): ESci 732, Geological Field Methods, 4 cr.; ESci 734, Applied Geophysics, 4 cr.; ESci 741, Geochemistry, 4 cr.; ESci 897/898, Seminar in Earth Sciences, 2 cr. each semester of the first year; ESci 899, Master's thesis, 6 cr. and an oral defense of the thesis.
   2) Additional courses to a minimum of 8 cr.: These courses are to be selected from 700- or 800-level courses in the department and/or from courses numbered 600 or above in disciplines outside of the department (chemistry, hydrology, soil science, physics, mathematics, etc.).

   Election of the core curriculum as well as the additional courses will depend upon each individual student's specialization and upon his/her preparation at the time s/he enters the program.

   Oceanography Option Requirements: This option is designed for students who wish to pursue the chemical, geological, and/or physical aspects of oceanography. Although the broad scope of the marine sciences will be presented, the emphasis in the program will be placed on estuarine, coastal, and continental shelf oceanography.
The option in oceanography normally includes:


2) Additional Courses to a minimum of 8 cr: The following are examples of courses that would be elected by students in the various specializations within the oceanography option:

   For Chemical Oceanography: chemistry courses numbered 600 or higher; ESci 895-Y, Advanced Chemical Oceanography; ESci 856, Estuarine and Marine Sedimentation.

   For Geological Oceanography: ESci 734, Applied Geophysics; ESci 856, Estuarine and Marine Sedimentation; mathematics and/or chemistry courses numbered 600 or higher; other 700- or 800-level courses in earth sciences.

   For Physical Oceanography: Fluid Dynamics; mathematics and/or physics courses numbered 600 or higher; ESci 734, Applied Geophysics; ESci 858, Dynamical Oceanography.

Because most students enter this option with an undergraduate major in one of the traditional sciences or engineering disciplines, it is expected that their exposure to formal courses in oceanography will be minimal. Election of the core curriculum as well as the additional courses will depend upon each individual student's particular specialization and upon his/her preparation at the time of entrance into the program.

725. IGNEOUS AND METAMORPHIC PETROLOGY
Textural, mineralogical, and chemical analysis, and phase rule and phase diagram interpretation applied to petrogenesis. Prereq: Principles of Mineralogy; Petrography/or permission. 4 cr.

732. GEOLOGIC MAPPING AND INTERPRETATION
Standard methods of geologic field mapping; interpretation of geologic maps and aerial photographs of selected areas. Course includes field mapping excursions to local areas and an 8-10 day exercise in a selected area of the Appalachian Mountains. $75 lab fee includes transportation and housing in the field. Prereq: permission. 4 cr.

734. APPLIED GEOPHYSICS
Gravity, magnetic, seismic, electrical, and thermal methods of investigating subsurface geology. Practical fieldwork and use of computers in data analysis. Prereq: calculus passed or taken concurrently; Intro. Geol.; one year of college physics/or permission. 4 cr.

741. GEOCHEMISTRY
Thermodynamics applied to geological processes; geochemical differentiation of the earth; the principles and processes which control the distribution and migration of elements in geological environments. 4 cr.

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

754. SEDIMENTATION-STRATIGRAPHY
Sedimentation: weathering, transportation, and deposition of modern sediments. Stratigraphy: classification of sedimentary rocks and principles of stratigraphic correlation. 4 cr.

758. INTRODUCTION TO PHYSICAL OCEANOGRAPHY
Ocean basins; physical properties of seawater; atmosphere-ocean interaction; general ocean circulation; waves, tides, tsunamis, and gulf stream; continental shelf and near shore processes; instrumentation and methods used in ocean research. Simplified physical and mathematical models demonstrate the important concepts. Prereq: one year of college physics; intro oceanog/or permission. 4 cr.

759. GEOLOGICAL OCEANOGRAPHY
Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prereq: intro geol; Intro Oceanog/or permission. 4 cr.

762. GLACIAL GEOLOGY
Glacial environment: glaciers as agents of deposition; interpretation of glacial deposits. Review of world glacial stratigraphy in light of causes of glaciation and climatic change. Prereq: intro geol; geomorphology/or permission. 4 cr.

781. PHYSICAL GEOLOGY
Materials and structures of the earth and erosive agents that modify them. Laboratory and field trips. For certified elementary or high school science teachers who need an introduction to the earth sciences. Not available for credit after completing intro geol. 4 cr.

782. HISTORICAL GEOLOGY
Evolution of physical features and life on the earth. Fossil organisms; methods of historical geology; laboratory and field trips. Prerequisite: ESci 781 or equivalent. For certified elementary or high school science teachers who need an introduction to the earth sciences. Not available for credit after completing ESci 402 or equivalent. 4 cr.
795. **TOPICS IN EARTH SCIENCES**


Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed above. Staff. 1-4 cr.

796. **HONORS PROJECT**

Independent research projects similar to ESci 795 for students with 3.0, or better, average in earth sciences. 2 or 4 cr.

797. **GEOLOGY COLLOQUIUM**

Study of selected topics in both classical and modern geological thought. For majors. 0 cr. Cr/F.

813. **X-RAY CRYSTALLOGRAPHY**

Theory and practice of diffraction of x-rays by crystals; lattices, symmetry, and structure analysis. Prereq: mineralogy or physical chemistry or equivalent. 3 cr. (Not offered every year.)

816. **MINERALOGY OF CLAYS**

The mineralogic composition, structure and properties, origin and mode of occurrence of clay minerals and clay materials. Prereq: permission. 3 cr. (Not offered every year.)

820. **ADVANCED IGNEOUS PETROLOGY**

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

821. **ADVANCED METAMORPHIC PETROLOGY**

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

841. **ANALYTICAL GEOCHEMISTRY**

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

856. **ESTUARINE AND MARINE SEDIMENTATION**

Unique aspects of sedimentation in marine and estuarine water with special emphasis on cohesive, fine-grained estuarine sediment erosion, transportation, and deposition. Laboratory includes basic statistical analysis of sedimentological data. Course includes completion of a project. Prereq: permission. 3 cr. (Not offered every year.)

858. **DYNAMICAL OCEANOGRAPHY**

The hydrodynamics of such ocean phenomena as waves, tides, and ocean turbulence; wind driven circulation on the continental shelf and deep ocean will be treated in detail. Prereq: ESci 758; M E 707/or permission. 4 cr. (Not offered every year.)

895, 896. **TOPICS IN EARTH SCIENCES**

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

897, 898. **SEMINAR IN EARTH SCIENCES**

A review and discussion of recent literature in the earth sciences. Required of graduate students in earth sciences. Staff. 1-3 cr.

899. **EARTH SCIENCES MASTER'S THESIS**

4 cr.

**Economics (Econ)**

**Director of Economics Studies:** Richard Hurd

**PROFESSORS:** Robert F. Barlow, Manley R. Irwin, John J. Korbel, Sam Rosen, Kenneth J. Rothwell, Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Allan J. Braff, John M. Burt, Jr., Fred R. Kaen, Richard L. Mills, Robert C. Puth

**ADJUNCT ASSOCIATE PROFESSOR:** James A. Smith

**ASSISTANT PROFESSORS:** Richard W. England, Richard Hurd, Evangelos Simos, Allen R. Thompson
Whittemore School of Business and Economics

The economics faculty of the Whittemore School, together with the resource economics faculty of the Institute of Natural and Environmental Resources, offers a program leading to the degree of Doctor of Philosophy. In addition, the economics faculty offers a plan of study culminating in the degree of Master of Arts.

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

Admission requirements in addition to those established by the Graduate School include: the Graduate Record Examinations (aptitude and advanced test in economics); T.O.E.F.L. for applicants from non-English speaking countries; three letters of recommendation from those acquainted with the applicant's work in his/her major.

Doctor of Philosophy Degree

Ph.D. candidacy requires written evidence of proficiency in economic theory, the history of economic thought and methodology, and quantitative methods. In special cases, oral examinations may also be required. The Ph.D. candidate is also required to participate in a minimum of two research workshops. At present, workshops exist in finance, political economy, labor economics, and econometrics.

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

Master of Arts Degree

The candidate for a master's degree may take a general course of study or the thesis option. The general requirements of the Graduate School and the following major requirements must be met:
1) 32 semester hours of graduate study which may include 8 hours of thesis work;
2) Minimum of 24 semester hours in courses numbered 700 and above and at least 12 hours in courses numbered 800 and above apart from Economics 899. Thesis;
3) Maximum of 8 semester hours in approved courses numbered 600 and above taken in related disciplines;
4) Written evidence of proficiency in economic theory and either the history of economic thought and methodology or quantitative methods.

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

715. MARXIAN ECONOMIC ANALYSIS
Marx's analysis of capitalism within the classical and radical tradition; methodology; organization of capital; labor theory of value; accumulation of capital; growth and distribution; economic crises. Critical evaluation of Marx's analysis. Prereq: intermed micro; intermed macro/or permission. 4 cr.

720. U.S. ECONOMIC HISTORY
From Colonial times to the present. Applied economic theory; economic models and interpretation of data. Influence of technology, industrialization, foreign trade, monetary factors, and government; non-economic factors. Prereq: intermed micro or macro or permission. 4 cr.

721. EUROPEAN ECONOMIC HISTORY
Western European and Mediterranean economies from medieval times to the Common Market. Economic models and interpretation of data. Capital accumulation, technology, trade, industrialization, monetary factors, and the role of government; relevant non-economic factors. Prereq: intermed micro or macro or permission. 4 cr.

725. STATISTICAL THEORY
Univariate and bivariate mathematical statistics; i.e., probability theory, discrete and continuous random variables and their distributions, moments and moment-generating functions, parameter estimation, hypothesis testing, correlation and regression analysis, analysis of variance. Prereq: calculus. 4 cr.

727. INTRODUCTION TO ECONOMETRICS
Representation of economic phenomena in mathematical terms; formulation of models of economic activity and the derivation therefrom of propositions which are subject to statistical test, primarily by means of multivariate regression analysis. Prereq: Econ 725 or permission. 4 cr.

735. ECONOMICS OF FINANCIAL MARKETS
Economic analysis of financial market systems. Topics include financial market functions, theories of saving and investment, financial intermediation, flow-of-funds analysis, loanable funds theory, interest rate forecasting, portfolio theory, capital asset pricing models, structure of interest rates (including term structure theory), and macroeconomic models of the financial sector. Prereq: Money and Banking or permission. 4 cr.
736. 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.

737. DECISION THEORY AND BAYESIAN METHODS
Utility, decision problems, prior and posterior distributions, sufficiency, estimation and hypothesis testing, linear models, and sequential sampling. Emphasis on applications to business and economics. Prereq: Math 735. 4 cr. (Not offered every year.) (Also offered as Math 737.)

741. SEMINAR IN PUBLIC FINANCE—THEORY AND POLICY
Selected topics in contemporary theoretical and policy problems of public finance. Prereq: Econ 641 or permission. 4 cr.

742. SURVEY OF URBAN ECONOMICS
Theoretical and empirical bases; policy alternatives for the problems of poverty, housing, urban renewal, transportation, local fiscal affairs, and pollution. Prereq: intermed micro or permission. 4 cr.

745. 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.

746. 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.

751. GOVERNMENT REGULATION OF BUSINESS
Analysis of government policy with reference to such problems as conspiracy, monopoly, mergers, unfair practices, and discrimination. This analysis includes a legal and economic appraisal of government policy alternatives. Prereq: Econ 651 or permission. 4 cr.

752. SEMINAR IN INDUSTRIAL ORGANIZATION AND PUBLIC POLICY
An examination of historical and contemporary developments in the theoretical and applied areas of industrial and commercial market structures, behavior and performance. Prereq: govt reg of busi; permission. 4 cr.

755. COLLECTIVE BARGAINING
Explores the historical development of the U.S. labor movement and the industrial relations system. Contemporary collective bargaining issues are discussed and the role of public policy in industrial relations is examined. Prereq: labor unions and the working class or permission. 4 cr.

756. 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.

758. MANPOWER AND EDUCATION PLANNING
Flows of human beings within and between the educational and manpower sectors of the economy, also related to flows of goods and services in the industrial sector. Interrelationships of these flows; construction of a computer simulation-model tracing the impact throughout the economy of manpower and educational-planning decisions. Prereq: prin of econ or permission. 4 cr.

761. NATIONAL ECONOMIC PLANNING
Planning in a market economy: the new industrial state. Planning as a substitute for markets: the developing countries. Planning as a way of transforming society; socialist economies; techniques of planning social and political issues related to various planning methods. Prereq: intermed micro or macro/or permission. 4 cr.

768. SEMINAR IN ECONOMIC DEVELOPMENT
A survey of the theories of the development process and an examination of the role of various forces of economic change in developing countries. Prereq: econ dev or permission. 4 cr.

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

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

825. MATHEMATICAL ECONOMICS
Principal mathematical techniques and their application in economics. Prereq: permission. 4 cr.
Education

826. EMPIRICAL ECONOMIC METHODS
Application of statistical and econometric methods to problems in economics. Special emphasis on problems such as multicollinearity and autocorrelation and their resolution. Computer application is stressed throughout the course. Prereq: Econ 726 or permission. 4 cr.

857-858. HISTORY OF ECONOMIC THOUGHT
The evolution of economic thought. Examination and critical appraisal of the work of major economists and major schools of economists. 4 cr.

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

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

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

878. ECONOMICS OF CENTRALIZED AND MIXED SYSTEMS
Economic analysis of pricing, resource allocation and income distribution problems in systems in which private property is absent or minimized and private market mechanisms are circumvented. Input-output analysis and optimal control theory. Prereq: Econ 877. 4 cr.

895. INDEPENDENT STUDY
Variable cr.

896. RESEARCH WORKSHOP
A) Finance; B) Political Economy; C) Labor Economics; D) Econometrics. 2 cr.

899. THESIS
Staff. 8 cr.

999. DOCTORAL RESEARCH
Staff.

Education (Educ)

Chairperson: Roland B. Kimball

PROFESSORS: Angelo V. Boy, Bud B. Khleif, Roland B. Kimball, Carleton P. Menge, Gerald J. Pine

ASSOCIATE PROFESSORS: Michael D. Andrew, Charles H. Ashley, Jason E. Boyton, John G. Chalatas, David D. Draves, Edward D. Durnall, Donald H. Graves, David J. Hebert, M. Daniel Smith, Deborah E. Stone, W. Dwight Webb


ADJUNCT PROFESSOR: Donald D. Durrell

ADJUNCT ASSOCIATE PROFESSOR: Richard H. Goodman

ADJUNCT ASSISTANT PROFESSORS: John R. Cavanaugh, David M.J. Cross

GRADUATE STUDIES COORDINATOR: David D. Draves

Admission to Graduate Standing

Admission to graduate standing in the Department of Education is granted to applicants meeting the entrance requirements of the Graduate School and accepted by the department. Applications must include Graduate Record Examination scores for the Aptitude Test.

Admission Requirements

1) Above average academic credentials; 2) above average scores on the Graduate Record Examination; 3) three strongly supportive letters of recommendation attesting to intellectual and personal competence from persons in a position to judge the applicant’s preparation and fitness for graduate work; 4) applicants for the Certificate of Advanced Graduate Study must meet the preceding admission requirements and also possess a master’s degree in an appropriate specialty, and follow general admission procedures.

The Admissions Committee of the education department meets according to the following schedule to review applications and make recommendations concerning admission of students to the Graduate School. Applications for part-time study in all programs and for full-time study in administration, developmental disabilities, early childhood, elementary education, secondary education, five-year teacher education, post M.A.T. and M.Ed. programs, and reading must be completed at least one week prior to the following action dates: December 1, 1978, for Semester II; April 2, 1979, for the summer session; and July 23, 1979, for Semester I, 1979-80. Applications for full-time study in counseling must completed at least one week before the program’s single action date: April 2, 1979.
Concluding Degree Experience

Candidates in a Master of Education program usually conclude degree work by completing one of four types of concluding experiences: 1) research thesis; 2) written comprehensive examination; 3) development of a written set of professional theses followed by an oral examination; 4) clinical experience. Students must enroll in Education 899, Thesis, when the research thesis is selected.

Candidates in the Master of Arts in Teaching program usually conclude degree work by completing a project closely related to the teaching internship.

Candidates in the Certificate of Advanced Graduate Study program in counseling usually conclude degree work by completing one of three types of concluding experiences: 1) research thesis; 2) written comprehensive examination; 3) development of a written set of professional theses followed by an oral examination.

Master's Degree Programs in Education

Seven graduate programs lead to the Master of Education degree: counseling, developmental disabilities, early childhood education, educational administration and supervision, elementary education, reading, and secondary education.

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

Counseling

Program Information: Angelo Boy, David Cross, David Hebert, Gerald Pine, and Dwight Webb.

The counseling program provides the graduate with entry credentials of a professional counselor, one who is able to:

1) Provide behaviorally relevant individual and group counseling relationships;
2) Function as a scholar-practitioner by developing a sophisticated interplay between counseling theory and practice, whereby each expands and enhances the other;
3) Function in any setting dedicated to the educational, vocational, social, and psychological emergence of the person.

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

Electives (8 credits): Educ 808, 819, 824, and 832 may serve as electives. In addition, in consultation with the advisor, electives may be selected from graduate level courses which are related to the behavioral sciences and offered by a department or school in the University.

Concluding Experience: Degree candidates must successfully complete one of the following: research thesis, written examination, or theses plus oral examination.

Developmental Disabilities

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

The developmental disabilities program prepares graduates to assume responsibility in the service delivery system for developmentally disabled citizens (i.e., mental retardation, cerebral palsy, convulsive disorders, autism, multiple handicaps), including: a) directing the interaction of various therapies and disciplines providing service to the developmentally disabled, b) coordinating, supervising, and administering human service programs for the developmentally disabled, c) planning and evaluating human service programs, and d) maintaining and improving such programs through public relations, community awareness, and grant procurement activities.

Candidates are expected to have prior experience in one of several related professions (such as nursing, medicine, occupational therapy, communications, disorders, psychology, physical therapy, social work, education), and/or a strong theoretical background in these disciplines.

At present, this program is available only to part-time admitted graduate students.

Core Requirements (28 credits): Educ 883, Advanced Psychology of Human Learning; Educ 854, Survey of Developmental Disabilities; Educ 855, Service Delivery Systems in Developmental Disabilities; SHS 798, Survey of Therapeutic Approaches Employed by Professionals Related to Developmental Disabilities; Educ 872, Educational Program Planning and Evaluation (or Admin 803, Human Behavior in Organizations); Educ 856-857, Field Practicum and Seminars in Developmental Disabilities.

Electives (8 credits, minimum): Elective courses may be selected, in consultation with the adviser, from the offerings of graduate departments of the University to meet individual needs and professional objectives.

Concluding Experience: Following successful completion of a minimum of 36 credit hours, including the core of required courses, each degree candidate must pass a three-part written comprehensive examination.

Early Childhood

Program Information: Donald Graves, Deborah Stone.

The early childhood program is a full-time program beginning with the summer session and continuing through the academic year (a two-year plan is also available). It prepares participants as early childhood
resource specialists with competence to assume roles as master teacher, program supervisor, curriculum consultant, staff development director, parent/home educator, family agency coordinator, or college-level instructor. The emphasis is on practicum experience coordinated with extensive coursework in related academic disciplines.

Intensive summer experience is devoted to study of the young child and an analysis of appropriate learning environments.

September through June, graduate students are completely responsible for setting up and staffing early learning centers in local school districts, private schools, and day-care facilities in which they work in a co-teaching situation with another participant in the program as well as with volunteer aides from the community. Candidates engage in coursework and seminars concurrent with practicum experience through study on the campus two afternoons and evenings per week. They are expected also to produce a monthly newsletter, provide workshops for staff and parent groups, and do independent study that results in papers of significance to be shared at the annual early childhood conference.

Visits to Follow-Through models and intervisitation among public schools, private schools, day-care centers, and other child-related agencies is encouraged.

Curriculum: 841, Child Development for the Early Childhood Professional; 843, Environment for Early Childhood; 800-801, Internship and Seminar in Teaching; 846, Assessment in Early Childhood; 850 Foundations of Early Childhood Education; 853, Seminar in Curriculum Study; 865, Educational Supervision; and 895, Independent Study in Education (36 credits).

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

Concluding Experience: Special program clinical experience—plan, execute, and participate in an annual early childhood conference at the New England Center for Continuing Education.

Educational Administration and Supervision

Program Information: Charles Ashley, Jason Boynton, and Roland Kimball.

For the experienced teacher to become qualified in the broad area of supervision and administration, grades K-12. Emphasis on the elementary and secondary school principalship and general instructional supervision.

Core Requirements (24 credits): 785, Tests and Measurements; 865, Educational Supervision; 853, Seminar in Curriculum Study; 861, Public School Administration; 863, Seminar in Educational Administration; and 869, Practicum in Educational Administration, or 866, Practicum in Supervision and Curriculum.

Electives (12 credits): Individually planned, with major portion selected from the following education courses: 797, Seminar in Con-
temporary Educational Problems; 864, Personnel and Communication in Educational Organizations; 867, Legal Aspects of School Administration; 868, Collective Bargaining; 883, Advanced Psychology of Human Learning; 884, Advanced Human Development; 886, Philosophy of Education; 888, Sociology of Education; 895, Independent Study in Education; and 899, Internship and Graduate Study.

Concluding Experience: Comprehensive oral examination based upon the thesis prepared by the candidate or major research study related to school administration, curricula, or educational supervision.

Elementary and Secondary Education

Program Information: Teacher Education Committee: Michael Andrew; Stephen Birrell, coordinator of teacher education; Ellen Corcoran; Ann Diller; David Draves; Carleton Menge; Sharon Oja; and John Williamson.

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

Core Curriculum (12 credits): Selections may be made from: 785, Tests and Measurements; 838, Sociology of Education: Social Organization of Schools and Community; 853, Seminar in Curriculum Study; 863, Advanced Psychology of Human Learning; 864, Advanced Human Development; 886, Philosophy of Education.

Electives (18 credits): In consultation with the student’s adviser and with his/her approval, electives may be taken in specialized areas from within the Department of Education, in the student’s major field, or in some combination of the two. A student using the research thesis option of the concluding experience will normally use twelve elective credits for Educ 881: Methods and Techniques of Educational Research (4 cr.) and Educ 899: Thesis (8 cr.).

Concluding Experience: Degree candidates must successfully complete one of the following: theses plus oral examination, or research thesis.

Reading

Program Information: John Cauley, Leo Geoffrion, Cynthia Homer.

The reading program provides professional training as special teacher of reading, clinician, and consultant for individuals seeking certification as reading specialists. The program is designed to meet standards recommended by the International Reading Association for the professional training of reading personnel and certification requirements of the state of New Hampshire for reading specialists. The program trains students in the areas of elementary and secondary reading foundations, clinical competencies, consultant and supervisory skills, and research capabilities.
Core Curriculum (28 credits): 807, Foundations of Reading Instruction; 808, Diagnosis of Reading Difficulties; 809, Remediation of Reading Difficulties; 810, Comprehensive Reading Methods in the Secondary School; 813, Field Practicum in Reading; 814, Seminar in Reading. Choose one of the following: 811, Clinical Experience in Reading—Elementary; 812, Clinical Experience in Reading—Secondary.

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

Concluding Experience: Degree candidates will successfully complete one of the following: written examination, theses plus oral examination, or research thesis.

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

Program Information: Stephen Birrell, coordinator of teacher education.

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

All professional education requirements for certification must be met either prior to or as a part of the master's degree programs for preservice teachers. These professional requirements include: 500, Exploring Teaching; 700, Educational Structure and Change; 701, Human Learning and Development; 703, Alternative Teaching Models; 705, Alternative Perspectives on the Nature of Education; and 800-801, Internship and Seminar in Teaching. Additional requirements for all prospective elementary teacher candidates include 706, Introduction to Reading Instruction in the Elementary School, and two from the following: Math 621, Number Systems for Elementary School Teachers; Math 622, Geometry for Elementary School Teachers; Math 623, Topics for Elementary School Teachers; or Math 703, Mathematics-Education K-6.

All candidates who do not participate in the Live, Learn, and Teach program must complete, or have completed prior to admission, either: 1) 500, Exploring Teaching, or 2) a one-semester teacher aide experience, or its equivalent, with a supportive recommendation from school staff. Participants in the Live, Learn, and Teach program experience the equivalent of Educ 500.

The Live, Learn, and Teach program is a 10-credit, seven-week experiential summer program which may be an integral part of the master's degree program, particularly for those students who have done no previous coursework in education. The summer program consists of Educ 831 or 835 (4 cr), 703 (4 cr), and 700 (2 cr). The program also satisfies the requirement for Educ 500.

Concluding Experiences: One of the following is required of all candidates for either degree: development of a set of professional theses followed by an oral examination, research thesis, or project.

Master of Arts in Teaching (Elementary and Secondary)

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

Professional Education Requirements (12-40 credits): Either as part of the degree program or prior to admission, required certification courses or their equivalents must be successfully completed: Educ 500, 700, 701, 703, 705, 800, 801. (In addition, for elementary teacher certification: Educ 706 and two courses from Math 621, 622, 623, 703.)

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

Electives (0-6 credits): These courses, selected in consultation with one's adviser, may be from those offered by the Department of Education or other departments. Credits in Educ 700, 701, 703, and 705 beyond those used to fulfill the professional education requirements may serve as electives.

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

Master of Education (Elementary and Secondary)

The Master of Education degree for preservice teachers is designed for those students who wish to concentrate their graduate study in the Department of Education.

Professional Education Requirements (12-40 credits): Either as part of the degree program or prior to admission, required certification courses or their equivalents must be successfully completed: Educ 500, 700, 701, 703, 705, 800, 801. (In addition, for elementary teacher certification: Educ 706 and two courses from Math 621, 622, 623, 703.)
Courses for an Education Area Concentration (12 credits): In consultation with one's adviser, courses offered by the Department of Education will be selected which concentrate on some aspect of the field of education. (For those seeking elementary teacher certification, Educ 706 may be included.)

Electives (0-6 credits): These courses, selected in consultation with one's adviser, may be from those offered by the Department of Education or other departments. Credits in Educ 700, 701, 703, and 705 beyond those used to fulfill the professional education requirements may serve as electives.

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

Certificate of Advanced Graduate Study

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

Counseling (C.A.G.S.)

This program is designed for those who possess a master's degree in counseling or an equivalent master's degree and want to pursue further study toward the Certificate of Advanced Graduate Study. The candidate for this certificate must successfully complete 32 graduate credits beyond the master's degree, and one of the following before graduation: written examination, oral examination, or research thesis.

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

Electives (12 credits): Elective courses available within the Counselor Education Program are: Principles and Procedures in Rehabilitation, Social and Psychological Aspects of Disability, Psychological Stress and Adaptation, and Marriage and Family Counseling.

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

Concluding Experience: Degree candidates must successfully complete one of the following: research thesis, written examination, or theses plus oral examination.

Educational Administration and Supervision (C.A.G.S.)

Designed for individuals who possess a master's degree or graduate study 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.

Candidates must complete a significant field project and internship of 12 semester hours within the administrative environment in which they intend to function. Courses are required in five competency areas: Institutional Analysis, Organizational Behavior, Policy Analysis, Managerial Leadership, and Instructional Leadership. Twelve semester hours include electives outside the Department of Education.

The program is based upon the following:

1) Students in this program pursue basic courses in educational administration and supervision as well as electives which will enable them to function more adequately within a specific administrative environment.

2) Because of the complex role of the school administrator, persons seeking preparation as administrators must demonstrate intellectual and personal competence of superior quality.

3) The graduate program for administrators will emphasize the ability to apply the relevant facts and formulations derived from administrative theory and research in the solution of significant operational problems.

Contact: Charles H. Ashley, associate professor of education, Morrill Hall, for further details regarding the Certificate of Advanced Graduate Study in Educational Administration and Supervision.

700. EDUCATIONAL STRUCTURE AND CHANGE

Organization, structure, and function of American schools; processes of change in education; how successful innovation is accomplished. Field experience options. Variable-credit modules. Sections listed in department prior to preregistration. Prereq: Educ 500 or permission of instructor, except for off-campus programs. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

701. HUMAN LEARNING AND DEVELOPMENT: EDUCATIONAL PSYCHOLOGY

Individual development; learning process analysis. Variable-credit modules on the theories, research, and implications of a specific topic offered each semester and summer. Sections listed in department prior to preregistration. Prereq: Exploring Teaching or permission except for off-campus programs. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

703. ALTERNATIVE TEACHING MODELS

Analysis and application of basic teaching models and techniques (from very teacher-directed to very student-centered). Observation of master classroom teachers and exemplary video-tapes; service as aides to master-teachers; seminars. Techniques and analysis
systems through observation of video-tapes, microteaching, completion of appropriate self-instruction units, and seminars. Variable credit modules; sections listed in department prior to preregistration. Prereq: Exploring Teaching or permission except for off-campus programs. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

705. ALTERNATIVE PERSPECTIVES ON THE NATURE OF EDUCATION
Students formulate, develop, and evaluate their own educational principles, standards, and priorities. Alternative philosophies of education; contemporary educational issues. Variable credit modules; sections listed in department prior to preregistration. Prereq: Exploring Teaching and departmental permission, except for off-campus programs. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

706. INTRODUCTION TO READING INSTRUCTION IN THE ELEMENTARY SCHOOLS
The reading process; current procedures and materials; diagnostic techniques; clinical 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 prior to entrance into fifth year; in this case the course satisfies reading requirement but is not applicable toward the 12 required graduate credits. 4 cr.

707. APPROACHES TO TEACHING READING AT THE SECONDARY LEVEL
The Reading Curriculum in the Secondary School. Analysis of the structural components (developmental, corrective, remedial); materials and methods of instruction and appraisal; instruments of measurement and evaluation in the comprehensive secondary reading program. 2 cr.
Teaching Reading through the Content Areas: Alternative and Application. Students learn new approaches, concepts, and methodologies of teaching reading, workshop to develop and produce instructional strategies and materials for an integrated reading-content program. 2 cr.

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

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

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

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

753. TEACHING THE CHILD WITH EMOTIONAL AND SOCIAL DIFFICULTIES
Nature and scope of emotional disturbances and social maladjustment in children including causes, characteristics, and treatment programs. 2 cr.

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

775. DIAGNOSTIC TEACHING OF READING
An overview of the classroom implementation of the diagnosis and remediation of reading disability for teachers, counselors, administrators, and other school personnel. 4 cr.

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

795, 796. INDEPENDENT STUDY
Juniors and seniors only with approval by appropriate faculty member. 2 or 4 cr.
Education

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

800, 801. **INTERNSHIP AND SEMINAR IN TEACHING**
A two-semester, full-time, supervised internship consisting of less than full teaching responsibility in selected educational settings and programs. Weekly seminars and occasional workshops held concurrently with internship. Admission by application. Variable 3 or 6 cr.

806. **APPROACHES TO LANGUAGE ARTS INSTRUCTION**
Analysis of current research and trends. Language development and literature, including contributions of allied disciplines such as semantics and linguistics. Focus on processes of communication and application to school curriculum. 4 cr.

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

808. **DIAGNOSIS OF READING DIFFICULTIES**
Investigation of the nature, causes, and correlates of reading disability. Study of diagnostic procedures and materials through case studies, discussions, demonstrations, and practice. Coreq or prereq: Educ 807; Educ 810. 4 cr.

809. **REMEDICATION OF READING DIFFICULTIES**
Procedures for remedying reading deficiencies and modifications of teaching necessary to adjust to diverse reading handicaps. Emphasis on a diagnostic teaching approach to reading remediation. Prereq: Educ 807 and 810; 808 (may be taken concurrently with 809). 4 cr.

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

811. **CLINICAL EXPERIENCE IN READING—ELEMENTARY**
Individual and small-group work with children provide opportunity for clinical analysis, microteaching, and evaluation. Seminars focus on the process of reading and language and the effects of a variety of materials and methods on learning. Prereq: Educ 809. 4 cr.

812. **CLINICAL EXPERIENCE IN READING—SECONDARY**
Supervised tutoring of secondary school students in order to develop techniques for improving reading skills. Seminars will focus on corrective techniques and the integration of reading skills to the content areas. Prereq: Educ 809. 4 cr.

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

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

818. **PRINCIPLES AND PROCEDURES IN REHABILITATION**
Introductory course integrating theory and practice in the field of rehabilitation. History and philosophy of rehabilitation as a social movement, including relevant legislation. Study of institutions. Role, function, and work of the counselor. Relation of the rehabilitation process to the total health and helping service delivery systems. Prereq: permission. 4 cr.

819. **SOCIAL AND PSYCHOLOGICAL ASPECTS OF DISABILITY**
Examination of historical and cultural concepts of human deviance and disability. Analysis of social, psychological, and vocational factors resulting from disabling and disadvantaged human conditions. Relationship of rehabilitation to disability and to individual adjustments. Field-based consultation with disabled individuals and rehabilitation agencies. Simulated, eight-hour disability project for each student. Prereq: permission. 4 cr.

820. **COUNSELING THEORY AND PRACTICE**
Basic approaches to counseling are examined—their theoretical foundations, process components, goals, and outcomes. 4 cr.

821. **PSYCHOLOGY OF CAREER AND PERSONAL DEVELOPMENT**
Career and personal development and how each influences the other; literature and research examined to clarify application to individual and group career-counseling and to career education. 4 cr.
ASSESSMENT IN COUNSELING
Evaluative instruments and methods which have particular use in counseling. Systematic procedures for measuring samples of an individual’s behavior and statistical concepts which 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.

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

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

COUNSELING LABORATORY
Field experience in counseling with supervision and seminar to integrate theory and practice. Class will provide a format for microcounseling, simulations, and contemporary professional issues. Prereq: Educ 820 and permission. 4 cr.

COUNSELING INTERNSHIP
Supervised application of fundamentals of counseling theory and practice in actual counseling relationships. Samplings of the fundamental counseling practices of students will be analyzed and evaluated. Open only to master’s degree candidates in UNH graduate program in counseling. Prereq: permission. 4 cr.

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

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

ADVANCED COUNSELING INTERNSHIP
Supervised application of advanced counseling theory and practice in actual counseling relationships. Samplings of the advanced counseling practices of students will be analyzed and evaluated. Open only to C.A.G.S. candidates in UNH graduate program in counseling. Prereq: Educ 826; permission. 4 cr.

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

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. (Summer Session only.) Prereq: admission to the M.A.T. program or M.Ed. program for preservice teachers. 8 cr.

MARRIAGE AND FAMILY COUNSELING
Theories and techniques. Counseling with different units of the family: individuals, relationships, subgroups, and multiple groups. Crisis intervention, problem solving, and counseling for growth and development. Practical issues in the profession. 4 cr.

SEMINAR AND PRACTICUM IN SECONDARY SCHOOL TEACHING
Supervised Practicum: An exploratory summer practicum in a local summer high school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a prepracticum workshop focusing on interpersonal skill development; 2) a prepracticum curriculum and instructional laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching on elementary level are available for candidates who wish to determine better what level of teaching they prefer. (Summer Session only.) Prereq: admission to the M.A.T. or M.Ed. programs for preservice teachers. 8 cr.

SOCIOLOGY OF EDUCATION: SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY
Schools in their socio-cultural 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. (Also offered as Soc 838.)
841. CHILD DEVELOPMENT FOR THE EARLY CHILDHOOD PROFESSIONAL
To understand child growth, components of the course involve students in extended contacts with significant adults related to children in an early learning environment. Includes home visits to interview parents, relatives, and to observe the child in the family setting. Extensive readings, discussions, case study models, film viewings, and continued in-depth child study. Prereq: previous experience with young children. 4 cr.

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

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

848. CONTEMPORARY INFLUENCES UPON EARLY CHILDHOOD EDUCATION
Survey of contemporary models in this country and abroad, largely through field experiences (United States, Canada, and England). Application of principles to individual student and specific early learning situations. Prereq: current involvement with a specific group of children. 4 cr.

850. FOUNDATIONS OF EARLY CHILDHOOD EDUCATION
Historical roots of contemporary practices. Perspective of historical precedents in content, methodology, and change. Study and review of child development, assessment, classroom environments. Prereq: Educ 841; 843; 846; and 848. 4 cr.

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

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

855. SERVICE DELIVERY SYSTEMS IN DEVELOPMENTAL DISABILITIES
Service delivery system models in developmental disabilities: pre- and postnatal, preschool, elementary, secondary, postschool, and adult occupational. Examination of the New Hampshire state plan for the provision of services and facilities for the developmentally disabled, as well as the plans of other states in the New England region; administrative, social, legal, and educational implications. Prereq: Educ 750. 4 cr.

856-857. FIELD PRACTICUM AND SEMINAR IN DEVELOPMENTAL DISABILITIES
One semester of supervised experiences in a diversity of agencies and facilities serving the developmentally disabled, a one-semester practicum experience in a particular setting approximating the student’s career choice, and biweekly seminars on topics related to the delivery of service to the developmentally disabled. Supervision will be provided by University faculty and staff. Prereq: permission. 8 cr.

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

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

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

863. SEMINAR IN EDUCATIONAL ADMINISTRATION
Cases and concepts in educational administration. Prereq: Educ 861. 4 cr.

864. 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.
865. EDUCATIONAL SUPERVISION
Theoretical foundations of supervisory behavior as a means of effecting changes in instructional practices; consideration of instruments and techniques based on those theoretical foundations; some opportunity for field projects utilizing instruments and techniques. Prereq: teaching experience. 4 cr.

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

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

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

869. PRACTICUM IN EDUCATIONAL ADMINISTRATION
Supervised practical experience in dealing with problems in educational administration. Prereq: Educ 863. 4 cr.

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

871. SCHOOL PLANT PLANNING
A study will be made of the techniques and procedures involved in the long-range planning of school facilities; for example, school population projections, characteristics of the educational program, space requirements, evaluation of existing facilities, future use of existing buildings, analysis of financial resources available, identification of reasonable alternatives, and an examination of the probable consequences of such alternatives to include educational effectiveness and tax impact. Prereq: Educ 863 or permission. 4 cr.

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

874, 875. ADMINISTRATIVE INTERNSHIP AND FIELD PROJECT
Field-based internship. Administrative experiences in one or several educational and community agencies. Participation in administrative and supervisory work of the agencies. Each intern completes a major field project requiring analysis and action appropriate for resolution of a significant administrative problem at the internship. 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. each semester.

881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH
Quantitative methods employed in the investigation of educational problems. Prereq: permission. 4 cr.

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

884. ADVANCED HUMAN DEVELOPMENT
Selected principles and skills mankind must consider in the attempt to maximize individual, social, and educational potential; emphasis on personal implementation. Prereq: Educ 701, Psyc 401, or equivalents. 4 cr.

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

**Chairperson:** Ronald R. Clark

**PROFESSORS:** Fletcher A. Blanchard, Ronald R. Clark, Albert D. Frost, Joseph B. Murdoch, Alden L. Winn

**ASSOCIATE PROFESSORS:** Glen C. Gerhard, Filson H. Glanz, Donald W. Melvin, John L. Pokoski, Kerwin C. Stotz, K. Sivaprasad

**ASSISTANT PROFESSORS:** John D. Aspnes, Michael R. Cannon, Paul J. Nahin

**GRADUATE COORDINATOR:** Glen C. Gerhard

To be admitted to graduate study in electrical engineering, a student should have completed a baccalaureate degree in electrical engineering or comparable training which included courses in mathematics and physical science, network theory, fields and waves, electronics, solid state circuits, semiconductor device theory, with appropriate laboratory experiences.

A minimum of 24 credits of coursework plus 6 credits of thesis or project are required for the master's degree. No specific course requirements are mandated; each candidate will meet with the departmental graduate committee to set up a program of study. Students are further required to demonstrate the ability to do independent and creative work by taking either E E 899 or 891-892. With the consent of the Graduate Committee, a student who has satisfied this requirement through industrial experience may substitute approved coursework.

Electrical Engineering 899 and 891-892 both involve equivalent independent theoretical and/or applied work under the guidance of a faculty member. The sequence 891-892 is to be completed in two consecutive semesters, with a letter grade given at the end of each semester. An interim report is submitted at the end of 891, and a final (oral and written) report at the end of 892. E E 899 requirements include the submission of a formal thesis suitable for binding. However, no two-semester time limit is imposed, and no interim or final letter grade is given.

Those who intend to undertake graduate work in electrical engineering must consult with the department graduate adviser in order to plan the program of study, since all courses are not given each year. Normally, a minimum of 12 credits of 800-level courses is required, not including 891-892 or 899.

The Electrical and Computer Engineering Department considers the development of professional communication skills, through a teaching assignment, a basic component of a graduate education. Every master's candidate is required to satisfactorily complete one year of E E 800 seminar; participation includes presentations as needed to satisfy the teaching requirements.

An interdepartmental Engineering Ph.D. Program is also available in the following areas of specialization: engineering system design, signal processing, theoretical and applied mechanics, and transport phenomena. Electrical engineering students would normally work in one of the first two areas. For details refer to the section entitled Engineering Ph.D. Program on page 82.

Since many graduate courses are given by demand, actual course offerings vary from semester to semester.

**Areas of Specialization**

The faculty of the Electrical and Computer Engineering Department has research interests in the following areas. Students in the M.S. Elec-
Biomedical and Clinical Engineering

Topics of study in these areas include biomedical instrumentation, computer applications to medical problems, patient safety, direct patient care, health delivery systems, and applications of signal processing and instrumentation techniques to medical areas.

A specialization in either of these areas may be elected by the student. Students specializing in Biomedical Engineering must complete E 783, 784, and 836 plus approved professional electives. Students in Clinical Engineering, in addition to the courses listed above, complete one year of internship in the Clinical Engineering Center (E 833-834). Additional details are available upon request.

Communications Systems and Information Theory

Areas of interest and activity include electromagnetic and acoustic wave technologies, and the identification of signals in the presence of noise through the use of coding, correlation, or optimal filtering. Related facilities for experiments extending from VLF to microwaves are available at a roof-top communications system for space, terrestrial, and ocean applications.

Computer Engineering and Digital Systems

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

Control and Systems Engineering

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

Geophysical Sensing and Propagation

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

Illumination Engineering

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

Ocean Engineering and Instrumentation

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

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

620. ELECTRONICS AND INSTRUMENTATION

For nonengineering or nonphysics students; no mathematical or engineering detail. Techniques for using electronic instruments and equipment. DC and AC circuits, electronic amplifiers, grounding and shielding problems, transducers, electronic instruments, schematic reading, transients, noise problems, and digital techniques. Prereq: junior standing. 4 cr.

711. DIGITAL SYSTEMS

Advanced switching theory techniques (design of unclocked sequential circuits, minimization of multiple output circuits, etc.) and digital design tools (L.S.I., multiplexing, etc.). Applications. Prereq: Introduction to Digital Systems or permission. 4 cr.

712. LOGICAL DESIGN OF DIGITAL COMPUTERS

Computer architectures, including arithmetic, memory, control, and input-output units; the trade-offs between hardware, software, and cost. "Hands on" laboratory experience with machine language programming, interfacing of peripherals, etc., on minicomputers and microcomputers. Prereq: Introduction to Digital Systems or permission. 4 cr.

714. MINICOMPUTER APPLICATIONS ENGINEERING

Organization and operation of minicomputer-based systems. Interfacing of special purpose peripherals, data structures, control structures, program and data organization, microprogramming, real-time monitor systems. Applications to communication, automated measurement, and process control systems. Prereq: Introduction to Digital Systems and programming experience/or permission. 4 cr.
727. **POWER SYSTEMS**
Modeling and planning of electric power transmission systems. Prereq: Electromechanical Energy Conversion. 4 cr.

741. **FLUID CONTROL SYSTEMS**
The mathematical modeling of hydraulic, pneumatic, and fluidic control elements and control systems. Methods are developed for the analysis of systems using gases or liquids as the working fluid. Methods for the synthesis of the parameters of the control elements, used in automatic control systems, are developed and methods of design of these systems are discussed. 4 cr. (Also offered as ME 741.)

745. **FUNDAMENTALS OF ACOUSTICS**
Acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics and measurement of acoustical sources; microphones; sound level; acoustical materials, ultrasonics; architectural acoustics. Prereq: General Physics II; Differential Eqns. 4 cr.

757. **FUNDAMENTALS OF COMMUNICATIONS**
Communications systems, Fourier analysis of signals, AM and FM detection, digital and sampled-data signals, noise in electrical circuits. Prereq: Introduction to Communication and Control. 4 cr.

758. **COMMUNICATION SYSTEMS**
Design of high frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free space propagation, propagation characteristics of the ionosphere. Prereq: Electromagnetic Fields and Waves II; E and M 757 or equivalent. 4 cr.

762. **ILLUMINATION**
Radiation; color and spectra; physics of light production; sources of ultraviolet, visible, and infrared energy; lamp circuitry; control of light; lighting design, applications of light in business, industry, school, home, and outdoors. 4 cr.

775. **APPLICATIONS OF INTEGRATED CIRCUITS**
Design and construction of linear and nonlinear electronic circuits using existing integrated circuits. Use of operational amplifiers. Laboratory course in practical applications of nondigital integrated circuit devices. 4 cr.

781. **OCEAN INSTRUMENTATION PROJECT**
Interdisciplinary solution of a real-world problem; measurements of physical, chemical, or biological parameters in an ocean or freshwater environment. Student team formulates system specification, assembles components, and designs a test procedure for demonstrating the feasibility of the prototype system. Written final report and oral demonstration before a panel of invited experts. Prereq: senior standing in engineering. 4 cr.

782. **CONTROL SYSTEMS**
Design and analysis of feedback control system. Stability criterion, time- and frequency-domain analysis, introduction to nonlinear systems. Prereq: permission. 4 cr.

783. **BIOMEDICAL ENGINEERING**
Engineering applied to cardiovascular, renal, gastrointestinal, sensory, reproductive, and other organ systems. Design and utilization of diagnostic, monitoring, and prosthetic techniques and devices. A design-oriented project required. Prereq: permission. 4 cr.

784. **BIOMEDICAL INSTRUMENTATION**
Survey of engineering principles applied to medicine including physiological measurements, biotelemetry, modeling and simulation, electrical safety, biosignal processing, and computer applications. Prereq: permission. 4 cr.

785. **UNDERWATER ACOUSTICS**
Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small and large signal considerations. Prereq: permission. 4 cr.

786. **INTRODUCTION TO RADIO ASTRONOMY**
Electromagnetic radiation, propagation. Positional astronomy and the radio sky, discrete radio sources, source structure distribution, the sun as a radio source, flare and burst activity, planetary emissions, quasars, pulsars, techniques of observation and data reduction, radiometry, polarimeters, correlation interferometers, aperture synthesis. Prereq: senior or graduate status in engineering or a physical science. 4 cr.

796. **SPECIAL TOPICS IN ELECTRICAL ENGINEERING**
New or specialized courses and/or independent study. Prereq: permission. 2 or 4 cr.

800. **GRADUATE SEMINAR**
This course includes periodically scheduled seminars presented by outside speakers, UNH faculty, and graduate students. Topics will be in general areas of interest to electrical and electronics engineers. Participants will prepare and give presentations to satisfy teaching practice requirements. 0 cr. Cr/F.
801. 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: Electromagnetic Fields and Waves I or equivalent. 3 cr.

802. 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: E E 801. 3 cr.

811. 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.

812. FILTER DESIGN AND SYNTHESIS
Network theoretical techniques basic to the design of electrical filters of various sorts. Approximation theory; driving point and transfer synthesis techniques; passive, active, and digital filters. Prereq: E E 811. 3 cr.

815. 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.

820. 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: E E 762 or equivalent experience. 3 cr.

833-834. PRACTICUM IN CLINICAL ENGINEERING
Seminars in medical equipment management; evaluation, testing, and standards; working experience in laboratory and in community hospitals in conjunction with the Clinical Engineering Center. Prereq; permission of instructor and director of CEC. A year-long continuous course; 3 credits each semester. "IA" grade (continuous course) will be given at the end of the first semester. 3 cr.

836. BIOMEDICAL ENGINEERING II
Applications of engineering in such areas as surgery, clinical-care units, neurophysiology, biotelemetry, modelling, and interaction of waves with biological tissues. Prereq: E E 783 or equivalent. 3 cr.

839. STATISTICAL THEORY OF COMMUNICATIONS
An introduction to probability theory and random waveforms leading to a discussion of optimum receiver principles. Topics include random variables, random processes, correlation, power spectral density, sampling theory, and optimum decision rules. 3 cr.

840. INFORMATION THEORY
A continuation of Electrical Engineering 839. Introduction of information-theory concepts. Topics include: message sources, entropy, channel capacity, fundamentals of encoding, Shannon's theorems. Prereq: E E 839. 3 cr.

841. DIGITAL SIGNAL PROCESSING
Theory and practice of digital signals processing; elements of nonrecursive and recursive digital filters, random number generators and simulation of time series, the fast Fourier transform, spectral estimation, envelopes and phases, modeling of time series. Samples of data from various physical experiments will be analyzed as student projects. Some exposure to programming is desirable. 3 cr.

842. DISCONTINUOUS CONTROL
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods which use the quantized nature of the information are also developed. 4 cr. (Also offered as M E 842.)

844. NONLINEAR CONTROL SYSTEMS
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Liapunov's stability theory; phase space methods; linearization techniques; simulation; frequency response methods; generalized describing functions; transient analysis utilizing functional analysis; and decoupling of multivariable systems. Prereq: E E 851. 4 cr. (Also offered as M E 844.)
851. ADVANCED CONTROL SYSTEMS I
State-space representation of systems. Analysis using state transition matrix. Controllability and observability. Synthesis of optimum control systems, including calculus of variations and maximum principle. Introduction to nonlinear and stochastic control-systems including stability concepts using Liapunov and Popov criteria. Sampled-data systems. Prereq: E E 782. 3 cr. (Also offered as M E 851.)

852. ADVANCED CONTROL SYSTEMS II
Special topics in control theory such as multivariate and adaptive control system; stochastic systems; Wiener and Kalman filter techniques; introduction to dynamic, linear, and nonlinear programming. Prereq: E E 851. 3 cr. (Also offered as M E 852.)

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

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

856. SWITCHING THEORY
Combinational circuits—including functional decomposition, nonbinary logic, and cellular networks. Sequential networks—including analysis, transient behavior, state reduction methods, state assignment, and synthesis. Prereq: E E 711. 3 cr.

860. COMPUTER ARCHITECTURE
Advanced topics in computer organization. Parallel and pipeline processing; associative and stack computers; microprogramming; virtual memory; current topics. Prereq: E E 712. 3 cr.

865. INTRODUCTION TO PATTERN RECOGNITION
Machine classification of data, feature space, clustering, linear separability, fictitious play algorithm, Braverman's hyperplane training and learning algorithm, learning and game playing computer programs that recognize patterns. Prereq: knowledge of computer terminal operation; BASIC language; Probability and Statistics or equivalents. 3 cr.

891-892. RESEARCH
3 cr. each semester.

898. INDEPENDENT STUDY
Independent theoretical and/or experimental investigation of an electrical engineering problem under the guidance of a faculty member. 1-3 cr.

899. MASTER'S THESIS
Total of 6 cr.

Engineering Ph.D. Program (Engr)

ENGINEERING Ph.D. COMMITTEE: Asim Yildiz, Glen C. Gerhard, Stephen S.T. Fan, Robert W. Corell

An interdepartmental engineering program offers graduate work leading to the degree of Doctor of Philosophy and is conducted by a combined engineering faculty. The program consists of areas of specialization within an interdepartmental structure, depending principally upon strengths in engineering, the engineering sciences, mathematics, and the physical sciences. An interdepartmental program is felt to be most meaningful since many contemporary engineering and scientific problems can be solved only through the cooperation of a variety of disciplines. Further, the boundaries between the classical disciplines in engineering and science have become less distinct. The
particular advantage of the nondepartmental program structure is that improved communication and cooperation develop among faculty and students of the different disciplines resulting in more meaningful academic and professional experiences.

Areas of Specialization

The Engineering Ph.D. program includes the following four areas of specialization:

Engineering System Design: Robert W. Corell, chairperson
Students entering this area of the Engineering Ph.D. Program can elect either one of two professional directions. The first seeks to develop 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 seeks to develop engineers with capabilities in the theory and analysis of large-scale complex systems. Concentration in an area of specific individual interest is combined with participation in a larger interdisciplinary project.

Current projects related to the area include coastal engineering, marine soil mechanics, submersibles and underwater habitats, ocean instrumentation, marine structures and buoy systems, arctic engineering, discontinuous control systems, vehicle and transportation systems, fluid power systems, nonlinear decoupling control, computer systems, vehicle dynamics, societal systems, facility systems, social and business systems, biomedical systems and instrumentation, and environmental engineering.

Signal Processing: Glen C. Gerhard, chairperson
This area of specialization is concerned with those analytic and experimental techniques that are involved in some aspect of the acquisition, detection, identification, or control of signals. In this context a signal is defined as any quantity which contains or conveys information. While the majority of signal processing systems are partially or wholly electrical in nature, many of the basic aspects of signal processing and utilization are common to a wide range of problems and applications in communications, medicine, environmental modeling, instrumentation, and control.

Current research areas include: acoustics, biomedical systems and instrumentation, computer and digital systems, digital signal processing, energy conversion and power systems control, fluidics, geophysical sensing, lighting design, nonlinear interacting system control, signal propagation, and systems modeling.

Theoretical and Applied Mechanics: Asim Yildiz, chairperson
Treated as an engineering science, this area brings together those aspects of engineering, physics, and applied mathematics that are relevant to the understanding and application of the dynamical and equilib-rium behavior of materials and structures. Included are the fields of solid mechanics, structural mechanics, classical and continuum mechanics, rheology, theoretical soil mechanics, biomechanics, elastodynamics, and acoustics.

Current research topics include macro- and micromechanics of composite material behavior, wood-fiber mechanics, viscoelastic material properties, structural dynamics, dynamics of ocean structures, structural optimization, elastodynamics, elastic wave propagation, scattering of elastic waves, electromagnetic wave propagation, theoretical soil mechanics, nonlinear dynamics, ocean engineering, ocean subbottom resources, oceanography, acoustic determination of the properties of layered media, Cosserat fields, dislocation theories, hydrodynamic turbulence, random vibrations, and estuary modeling.

Transport Phenomena: Stephen S.T. Fan, chairperson
This area deals with the subjects of fluid mechanics, heat transfer, mass transfer, and coupled phenomena in such areas. In addition to their fundamental role in traditional engineering activities, transport-phenomena studies are making significant contributions in the areas of energy production and utilization, environmental control, oceanography, space exploration, and biomedical engineering.

Current research activities include solar energy, new energy sources, pollution control, biomedical engineering, combustion, adsorption, heat transfer with phase change, liquid pumping cavitation, vortex flow, coal liquefaction and particle formation, and polymer processing.

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, a student must present evidence that s/he has sufficient background in the area in which s/he proposes to specialize.

Following entrance into the program, a guidance committee will be appointed for the student by the dean of the Graduate School upon recommendation of the chairperson of the student's area. This committee will assist the student in outlining the program and in preparing for the qualifying examination and may require him/her to take specified course work, with or without credit. The committee will also conduct an annual in-depth review of the student's progress, through written and/or oral examinations, and following the substantial completion of the student's coursework, will administer the qualifying examination. This committee is also responsible for administering any language examination and/or research tool proficiency requirements that are required of the area of specialization.

Upon the successful completion of the qualifying examination and other proficiency requirements, a doctoral committee will be appointed
English (Engl)

Chairperson: Jean E. Kennard

PROFESSORS: Thomas A. Carnicelli, Carl Dawson, Robert Hapgood, Jean E. Kennard, Edmund G. Miller, Donald M. Murray, Philip L. Nicoloff, John C. Richardson, Mark R. Smith, Thomas A. Williams, John A. Youn


ASSISTANT PROFESSORS: Lester A. Fisher, Andrew H. Merton, Thomas Newkirk, Hugh M. Potter III, David V. Siddall

The Department of English offers three advanced degrees, Master of Arts, Master of Science for Teachers, and Doctor of Philosophy. All applicants are required to submit Graduate Record Examination scores for the Aptitude Test and the Advanced Test of Literature in English. Applicants for the Ph.D. are normally expected to have a reading knowledge of at least one foreign language.

Master of Arts Programs

Master of Arts in Literature

The Master of Arts may be undertaken as a terminal degree or as preparation for a doctoral program. The program encourages students to pursue their individual interests and to correct deficiencies in their undergraduate training.

An M.A. candidate must pass eight four-credit courses. Six courses, including at least three seminars and either English 895 or 896, must be at the 800 level. At least four courses must be in English or American literature (as distinct from courses in critical analysis, linguistics, writing, teaching methods, or other literatures). Each M.A. candidate must pass at least 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 one of the following languages: French, German, Greek, Italian, Latin, Russian, Spanish. Each candidate for the M.A. degree must register for four credits of English 895 or 896 and produce a substantial scholarly paper.

Course Requirements

Course work requirements will be developed on an individual basis by each student’s guidance committee. Since each area of specialization has its own specific course requirements, an interested student should contact the area chairperson to determine the particular coursework and research activity that may be applicable to his/her educational goals.

Except for Doctoral Research (999), students will follow a program of study consisting of courses from within the chemical, civil, electrical, and mechanical engineering departments, many of which have been established particularly for this program, and from related departments appropriate to the student’s needs. A student should consult specific course offerings and descriptions.

999. DOCTORAL RESEARCH
Master of Arts in Writing

The Master of Arts in Writing is designed for students who intend to become professional writers. Seven 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.

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.

Master of Arts in English Language and Linguistics

Students who wish to specialize in any of the various areas of English language and linguistics may design an M.A. program to meet their interests. The graduate committee of the department must approve all such program designs. Specialties include applied linguistics and the teaching of English as a second language as well as the traditional subfields of linguistics. Psycholinguistics is offered through the psychology department. Seven four-credit courses, including two seminars, must be completed, plus an independent study course leading to a scholarly paper. Reading knowledge of one foreign language is required.

Master of Arts with an Emphasis on Junior College Teaching

This is a special M.A. program designed for students committed to junior-college teaching. Regular graduate courses, specially designed seminars, and teaching internships are features of the program. A candidate must pass a reading examination in a foreign language or take a course in applied linguistics. Further details are available from the secretary for graduate programs, Department of English.

Master of Science For Teachers

The Master of Science for Teachers is designed for high school teachers. No foreign language is required. The student must pass eight 4-credit courses in English, numbered 700 and above, normally including at least one course in the teaching of writing and in the study of language, which will not be a repetition of undergraduate work. Applicants should consult the General Regulations of the Graduate School for the special admissions requirements for this program.

Doctor of Philosophy

To be admitted to the Ph.D. program, the student must hold an M.A. degree or be in the final stage of completing requirements for the degree.

The Ph.D. program offers professional training in the teaching of literature and language. 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. In addition to meeting course requirements, each student must pass: 1) reading examinations in two foreign languages (French, German, Greek, Italian, Latin, Russian, Spanish); 2) near the beginning of the work for the Ph.D. degree, a 90-minute oral general examination; and 3) a later written and oral qualifying examination in three areas related to his/her proposed dissertation: an historical period, a genre or a related field, and a major author. A student must also write a dissertation and defend it at a final oral examination.

M.A. and Ph.D. students holding assistantships teach under supervision; such teaching is considered a vital part of the student's professional training. At least a year of intern teaching or its equivalent is required of all doctoral candidates.

Graduate students should note that not all seminars are offered every year. A detailed guide to the department's programs is available from the secretary for graduate programs, Department of English.

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

701-702/801-802. ADVANCED WRITING OF FICTION
Prereq: Writing Fiction or equivalent; permission. May be repeated for credit with the approval of the department chairperson. 4 cr.

703-704/803-804. ADVANCED NONFICTION WRITING
Prereq: permission. May be repeated for credit with the approval of the department chairperson. 4 cr.

705-706/805-806. ADVANCED WRITING OF POETRY
Prereq: Writing Poetry or equivalent; permission. May be repeated for credit with the approval of the department chairperson. 4 cr.

707/807. FORM AND THEORY OF FICTION
The problems, aims, and structures of fiction from the point of view of the writer. 4 cr.
English

708/808. FORM AND THEORY OF NONFICTION
Contemporary nonfiction from the point of view of the writer, emphasizing the choices the writer faced in the process of research and writing. 4 cr.

709/809. FORM AND THEORY OF POETRY
From the writer's point of view. Readings in major literary figures who have shaped American poetry in the twentieth century. 4 cr.

712. CRITICAL ANALYSIS OF EXPOSITION
For the English-teaching major; students analyze essays and write nonfiction prose. Variety of critical approaches; several methods of teaching composition. 4 cr.

713, 714/813, 814. LITERARY CRITICISM
Major critics from Plato to the present and the chief critical approaches to literature. 4 cr.

715/815. APPLIED LINGUISTICS
Methods of teaching and learning foreign languages; background work on theories of language acquisition; the methodology of teaching English as a second language. Students interested in teaching other languages may do their projects on those languages. 4 cr.

716/816. PROBLEMS IN APPLIED LINGUISTICS
Variable topics course; problems such as language acquisition in children and adults, bilingualism, and linguistic field methods. 4 cr.

718/818. ENGLISH LINGUISTICS
Introduction to linguistics; transformational, generative grammar. 4 cr.

719. ENGLISH GRAMMAR
Traditional and contemporary approaches to the structure of English; morphology and syntax, parts of speech, phrases, clauses, sentences, punctuation, etymology. 4 cr.

720. NEWSPAPER INTERNSHIP
Students intending to pursue careers in journalism spend a semester working full-time for a daily newspaper under close supervision of editors. Reporting is stressed, but the student may do some editing as well. The number of internships is very limited. Prereq: Newswriting or equivalent; permission. Variable, max. 16 cr.

741/841. LITERATURE OF EARLY AMERICA
Prose and poetry of the periods of exploration, colonization, early nationalisms, Puritanism, Enlightenment. Individual works and historical-cultural background. 4 cr.

742/842. AMERICAN LITERATURE, 1815-1865
Fiction, nonfiction, and poetry in the period of romanticism, transcendentalism, nationalism. Individual works and cultural background. 4 cr.

743/843. AMERICAN LITERATURE, 1865-1915
Fiction, nonfiction, and poetry in the period of realism, naturalism, industrialism, big money. Individual works and cultural background. 4 cr.

744/844. AMERICAN LITERATURE, 1915-1945
Fiction, poetry, and drama in the period of avant-garde and leftism, jazz age, and depression. Individual works and cultural background. 4 cr.

745/845. CONTEMPORARY AMERICAN LITERATURE
A gathering of forms, figures, and movements since 1945. Individual works and cultural background. 4 cr.

746/846. STUDIES IN AMERICAN DRAMA
Topics vary from year to year. Examples: twentieth-century American drama; contemporary playwrights; theatricality in American life. 4 cr.

747/847. STUDIES IN AMERICAN POETRY
Topics vary from year to year. Examples: poets of the Open Road; Pound and his followers; major American poets; contemporary American poetry. 4 cr.

748/848. STUDIES IN AMERICAN FICTION
Topics vary from year to year. Examples: the romance in America; the short story; realism and naturalism; the city novel; fiction of the thirties. 4 cr.

749/849. MAJOR AMERICAN AUTHORS
Intensive study of two or three writers. Examples: Melville and Faulkner; Fuller, Emerson, and Thoreau; James and Wharton; Dickinson and Frost. 4 cr.
750/850. SPECIAL STUDIES IN AMERICAN LITERATURE
   Topics vary from year to year. Examples: the puritan heritage; ethnic
   literatures in America; landscape in American literature; five
   American lives; Pragmatism; American Humor; Transcendentalism;
   women regionalists. 4 cr.

751/851. MEDIEVAL EPIC AND ROMANCE
   Two major types of medieval narrative in translation; comparative
   study of works from England, France, Germany, and Iceland.
   Beowulf, Song of Roland, Nibelungenlied, Gottfried's Tristan, Njal's
   Saga, and Malory's Morte d'Arthur. 4 cr.

752/852. HISTORY OF THE ENGLISH LANGUAGE
   The evolution of the English language and relation between
   linguistic change and literary style. 4 cr.

753/853. OLD ENGLISH
   Introduction to Old English language and literature through
   readings of selected poetry and prose. 4 cr.

754/854. BEOWULF
   A reading of the poem and an introduction to the scholarship. Pre-
   req: Engl 753. 4 cr.

755, 756/855, 856. CHAUCER
   755: Chaucer's allegorical poems and Troilus and Criseyde.
   756: The Canterbury Tales. 4 cr.

757-758/857-858. SHAKESPEARE
   757: Surveys of a number of representative plays. 758: Studies a few
   plays more intensively. 4 cr.

759/859. MILTON
   Milton's life and times, all his poetry, and a selection of his prose.
   4 cr.

763/863. 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, Cer-
   vantes, Erasmus, and Thomas More, as representative of the early
   English Renaissance. 4 cr.

764/864. LITERATURE OF THE ELIZABETHANS
   Shakespeare and his contemporaries. Spenser's Fairie Queene,
   Sidney's Astrophil and Stella, Shakespeare's Sonnets, Marlowe's
   Dr. Faustus: their literary and intellectual backgrounds. 4 cr.

767, 768/867, 868. LITERATURE OF THE RESTORATION AND
   EIGHTEENTH CENTURY
   Texts studied closely; attention to how texts reflect the central in-
   tellectual problems of their age. 767: Dryden, Rochester, Restora-
   tion plays, Bunyan, Defoe, Montesquieu, and Swift. 768: Pope,
   Fielding, Johnson, Boswell, Voltaire, Sterne, Rousseau, Beckford,
   Diderot, and Blake. 4 cr.

769, 770/869, 870. THE ENGLISH ROMANTIC PERIOD
   769: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770: Byron,
   Shelley, Keats. 4 cr.

771, 772/871, 872. VICTORIAN PROSE AND POETRY
   771: Carlyle, Mill, Ruskin, Newman, Tennyson, and Browning. 772:
   Arnold, Clough, the pre-Raphaelites, Swinburne, Hopkins, Hardy,
   Housman, and others. 4 cr.

773, 774/873, 874. BRITISH LITERATURE OF THE 20th CENTURY
   Conrad, Joyce, Yeats, Eliot, Woolf, Lawrence, Auden, and others.
   4 cr.

775/875. IRISH LITERATURE
   Historical survey. Works in Irish (read in translation) such as The
   Cattle Paid of Cooley, medieval lyrics, and Mad Sweeney. Works in
   English from Swift to the present. 20th century literary achievement:
   Joyce, Yeats, Synge, O’Casey, Beckett, and Flann O’Brien. 4 cr.

781/881. ENGLISH DRAMA TO 1800
   Development from the Middle Ages through the 18th century, em-
   phasizing the Elizabethan-Jacobean period and contemporaries of
   Shakespeare (eg. Marlowe, Jonson, Webster). Selected plays from the
   Middle Ages, Restoration, and 18th century. 4 cr.

782/882. MODERN DRAMA
   Major English, American, and (translated) European plays by such
   playwrights as Shaw, Ibsen, Chekhov, Strindberg, Pirandello,
   O'Neill, Brecht, Beckett, Williams, Miller, Pinter. Live and filmed per-
   formances as available. 4 cr.

783/883. 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.

784/884. 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.
785/885. MAJOR WOMEN WRITERS
Intensive study of several writers. Selections vary from year to year. Examples: Woolf and Lessing; Dickinson and Lowell; Charlotte and Emily Brontë; Atwood, Laurence and Oates. 4 cr.

791-792. ENGLISH EDUCATION—PROBLEMS IN THE TEACHING OF HIGH SCHOOL ENGLISH
Methods and techniques of teaching language and literature in grades 7-12. Required of all students in the English-teaching major. Open to English majors with permission of instructor. No credit toward the English major. 2 cr.

793/893. PHONETICS AND PHONOLOGY
Phonetics and phonology in the context of linguistic theory; comparisons of English to other languages. Prereq: a basic linguistics course or permission. 4 cr.

794/894. SYNTAX AND SEMANTIC THEORY
Relation between grammar and meaning; special reference to poetic language. Prereq: Engl 718; Engl 752/or permission. 4 cr.

795/796. INDEPENDENT STUDY
Open to highly qualified juniors and seniors both semesters. To be elected only with permission of the department chairperson and of the supervising faculty member or members. Barring duplication of subject, may be repeated for credit up to a maximum of 16 credits. 1-16 cr.

797, 798/897, 898. SPECIAL STUDIES IN LITERATURE

817. SEMINAR IN TEACHING WRITING
Students are introduced to the writing process and experience the process themselves by writing and exploring methods of teaching writing. One three-hour meeting plus individual conferences each week. Prereq: permission. 4 cr.

820. SEMINAR IN LINGUISTICS
4 cr.

821. SEMINAR—STUDIES IN OLD ENGLISH
4 cr.

824. SEMINAR—STUDIES IN MEDIEVAL LITERATURE
4 cr.

825. SEMINAR—STUDIES IN SIXTEENTH-CENTURY LITERATURE
4 cr.

827. SEMINAR—STUDIES IN SHAKESPEARE
4 cr.

828. SEMINAR—STUDIES IN MILTON
4 cr.

829. SEMINAR—STUDIES IN EARLY SEVENTEENTH-CENTURY LITERATURE
4 cr.

830. SEMINAR—STUDIES IN EIGHTEENTH-CENTURY LITERATURE
4 cr.

832. SEMINAR—STUDIES IN THE ROMANTIC PERIOD
4 cr.

833. SEMINAR—STUDIES IN THE VICTORIAN PERIOD
4 cr.

834. SEMINAR—STUDIES IN TWENTIETH-CENTURY BRITISH LITERATURE
4 cr.

837. SEMINAR—STUDIES IN AMERICAN LITERATURE OF THE NINETEENTH CENTURY
4 cr.

838. SEMINAR—STUDIES IN TWENTIETH-CENTURY AMERICAN LITERATURE
4 cr.

839. PROBLEMS IN TEACHING ENGLISH
Special topics in teaching within the discipline of English. Inquire at the department to see what topics in the teaching of literature, language, or writing may be scheduled. Open only to graduate students with a professional interest in teaching or to practicing teachers. 1-6 credits depending on the specific course.

840. SEMINAR—STUDIES IN ENGLISH DRAMA
4 cr.
895, 896. READING AND RESEARCH
Graduate faculty. 4 or 8 cr.

899. MASTER'S THESIS
6 cr.

999. DOCTORAL RESEARCH

Entomology (Ento)

Chairperson: G. Thomas Fisher
PROFESSOR: Robert L. Blickle
ASSOCIATE PROFESSORS: James S. Bowman, G. Thomas Fisher, R. Marcel Reeves
ASSISTANT PROFESSOR: John F. Burger
ADJUNCT ASSISTANT PROFESSOR: Arthur H. Mason

For admission to graduate study in entomology an applicant is expected to have at least the basic (Entomology 402) course in entomology as well as adequate preparation in the allied sciences of chemistry, botany, and zoology. Students lacking the necessary background courses may be required to complete certain of these courses which do not carry credit before they are admitted to full candidacy for a degree.

The program of graduate study is designed to meet the needs of those students planning to take further work leading to a career in professional entomology. Areas of specialization include taxonomy, ecology, ethology, biological control, pest management, chemical control, problems in medical entomology, forest entomology, and agricultural entomology. A thesis is required of all candidates for the master's degree. An oral examination on the thesis is required. Students are given the opportunity to assist the professional staff in field research and as laboratory assistants, and they are also encouraged to attend professional meetings in their appropriate fields.

No language requirements are made for the M.S. degree.

704. MEDICAL ENTOMOLOGY
Especially for students interested in public health or medicine. Insects and arachnids in relation to public health; the biology and control of important disease carriers. Elective for juniors and seniors. Lab. Mr. Blickle. 4 cr.

705. TAXONOMY OF INSECTS
Concepts, history, procedure, nomenclature and their use applied to a selected taxon. Prereq: permission. Mr. Blickle. 4 cr.

706. SOIL ARTHROPODS
Biology and systematics of terrestrial arthropods; springtails, sowbugs, myriapods, mites, spiders and other arachnids. Lab. Prereq: permission. Mr. Reeves. 4 cr.

707. IMMATURE INSECTS
Identification of immature insect stages, especially the holometabolous orders. Aquatic forms not included. Morphological features necessary for determination. Prereq: permission. Mr. Blickle. 4 cr.

708. INSECT MORPHOLOGY
The study of the external and internal anatomy of insects. Prereq: permission. Mr. Blickle. 4 cr.

709. AQUATIC INSECTS
Identification and biology of aquatic forms of insects. Prereq: permission. Mr. Blickle. 4 cr.

710. INSECT PHYSIOLOGY
An advanced study of the insect organs and their functions. Prereq: permission. Staff. 4 cr.

720. AGRICULTURAL ENTOMOLOGY
For advanced students interested in agribusiness. A survey of economic insect pests on forage, fruit, and vegetable crops. Life cycles, damage, and current methods of control are studied. Lab. Prereq: permission. Mr. Fisher. 4 cr.

721. PRINCIPLES OF BIOLOGICAL CONTROL
The natural and applied aspects of biological control of insect and plant pests. Prereq: permission. Mr. Reeves. 4 cr. (Not offered every year.)

722. CHEMICAL CONTROL OF INSECTS
For advanced students in applied entomology. A systematic review of the chemical groups utilized for insect control; studies in modes of pesticide entry and toxicology. Basic understanding of chemistry is desired. Prereq: permission. Mr. Fisher. 4 cr.

723. REGULATORY PEST CONTROL
For those students preparing for careers dealing directly with or associated with the movement of agricultural commodities in internal and foreign trade; emphasis on legal documents, federal and state statutes. Prereq: basic entomology and plant pathology courses; permission. Mr. Mason. 2 or 4 cr. (Alternate years; offered spring 1979.)
Genetics

724. STRUCTURAL PEST CONTROL
For students wishing to study household and industrial entomology. Lab. Prereq: permission. Mr. Fisher. 4 cr.

801, 802. GRADUATE ENTOMOLOGY
Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Mr. Blickle, Mr. Reeves, Mr. Fisher, and Mr. Bowman. Subject matter, hours, and credits to be arranged.

899. GRADUATE ENTOMOLOGY—MASTER'S THESIS
Mr. Blickle, Mr. Fisher, Mr. Reeves, and staff. Hours and credits to be arranged. 6-10 cr.

Genetics Program (Gen)

Chairperson: Owen M. Rogers

PROFESSORS: James P. Barrett, Walter M. Collins, Gerald M. Dunn, D. MacDonald Green, Harold W. Hocker, Jr., Frank K. Hoornbeek, Lincoln C. Peirce, Owen M.M. Rogers
ASSISTANT PROFESSOR: W.T. Adams
ADJUNCT ASSISTANT PROFESSOR: Peter W. Garrett

The interdepartmental Genetics Program offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy.

A qualified student is admitted to the program with the approval of the genetics faculty and the chairperson of the department in which he/she has 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. All students will be examined shortly after they arrive in order to diagnose their preparation in basic genetics. Students lacking the appropriate preparation may be admitted but will be required to complete certain courses without graduate credit.

The Aptitude section of the Graduate Record Examination is required.

The program is conducted by faculty members from animal sciences, biochemistry, the Institute of Natural and Environmental Resources, microbiology, plant science, the School of Health Studies, and zoology, as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station.

The core curriculum in genetics requires students in the Ph.D. program to take a minimum of one course from each of the following groups of courses: 1) Population Genetics—Introductory course, Gen 705; 2) Molecular Genetics—Biochemical Genetics, Gen 770; Microbial Genetics, Micro 804; Developmental Genetics, PISc 832; 3) Classical Genetics—Plant Genetics, PISc 851; Cytogenetics, PISc 853; Quantitative Genetics, AnSc 811; Human Genetics, Zool 707. All students are required to participate in a one-year directed teaching experience. In addition, all students are required to attend genetics seminars.

The requirements for the M.S. candidates will be a minimum of one course from each of any two of the above three groups of courses.

Master of Science Degree
The program for the Master of Science degree is formulated by the student with the approval of the guidance committee. Candidates for the degree will be required to complete a thesis, pass an oral examination covering graduate courses and thesis, and complete courses designated in the core curriculum.

Doctor of Philosophy Degree
The chairperson of the Genetics Program, with the concurrence of the chairperson of the department of major interest, will nominate the student's guidance and doctoral committees which will administer the qualifying and final examinations. Specific course requirements will be developed by the student and the guidance committee, and will include the courses in the core curriculum. Students must complete a dissertation on original research in genetics.

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

705. POPULATION GENETICS
Population growth and regulation; distribution of genes; factors affecting gene frequency; genetic load; cost of natural selection; ecological genetics. Prereq: introductory genetics; introductory statistics/or permission. 4 cr. (Not offered every year.)

706. GENETICS LABORATORY
Experiments and demonstrations in classical, developmental, and population genetics and cytogenetics, utilizing a wide range of organisms and techniques. Genetics faculty. Pre- or coreq: Principles of Genetics or equivalent; permission. 2 cr.

740. EVOLUTIONARY BIOLOGY
The synthetic theory of evolutionary processes in the origin of life, species, and higher groups; sources of genetic variability, population structure, causes of evolution; ecological adaptations in animals, plants, and man; evolution of communities; molecular evolution and rate of evolution. Prereq: introductory genetics/or permission. 4 cr. (Not offered every year.)
770. BIOCHEMICAL GENETICS
The biochemical mechanism of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prereq: Bchm 751 or permission. 4 cr. (Not offered every year.)

802. DESIGN OF EXPERIMENTS
The philosophy of experimental design and how it relates to standard statistical designs. Topics include the roles of replication and randomization, factorially arranged treatments, latin squares, incomplete nonfactorial designs, fractional replication and confounding, and crossover designs. Mr. Urban. Prereq: FoRs 711; Digital Computer Systems; or permission. 3 cr. (Not offered every year.)

812. ADVANCED STATISTICAL METHODS
Methods and techniques for handling typical problems which 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. Mr. Urban. Prereq: FoRs 711; Digital Computer Systems; or permission. 3 cr. (Not offered every year.)

895-896. SPECIAL TOPICS IN GENETICS
Intended for study in specialty areas not ordinarily included in other courses. May involve formal classes, discussions, or independent investigations. Prereq: permission of staff concerned. 2-4 cr.

898. GENETICS SEMINAR
Presentation and discussion of selected genetic topics. Staff. 1 cr. (May be repeated.)

899. MASTER'S THESIS
6-10 cr.

999. DOCTORAL RESEARCH

Courses Available in Related Areas

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

Animal Sciences

711. COMPARATIVE ANIMAL GENETICS
How heredity affects domestic animals, poultry, other mammals, and fish; emphasis on the organism and population. Quantitative inheritance, principles of selection, disease resistance also studied. Statistical and experimental techniques. Lab. Prereq: 4 cr. of genetics or permission. 4 cr.

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

Institute of Natural and Environmental Resources

711. STATISTICAL METHODS II
Intermediate course in statistics; 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 I or equivalent. 4 cr.

Forest Resources

720. FOREST GENETICS
Genetics of forest tree improvement; variation in natural populations, evolutionary principles, and breeding methods. Transportation fee. Lab. Prereq: Principles of Genetics; Silviculture; or permission. 3 cr. (Not offered every year.)

Microbiology

804. MICROBIAL GENETICS
Expression, regulation, recombination, and transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal inheritance. Lab. Prereq: Gen Micr; permission. 4 cr. (Not offered every year.)

Plant Science

732. PLANT DEVELOPMENTAL GENETICS
Gene action in relation to development in plants; isozymes and differentiation; chromosomal proteins and gene regulation; temporal specificity of gene action; nuclear-cytoplasmic interactions; chemical gradients and gene activation. Prereq: introductory genetics and physiology. 4 cr. (Not offered every year.)

773. METHODS AND THEORY OF PLANT BREEDING
Plant breeding systems for qualitative and quantitative plant improvement. Prereq: introductory genetics; introductory statistics/ or permission. Mr. Peirce. 3 cr. (Not offered every year.)
851. PLANT GENETICS
Linkage, euploid, aneuploid, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prereq: Genetics. 3 cr.
(Not offered every year.)

853. CYTOGENETICS
Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cyogenetic analysis. Prereq: Genetics; Cytology. 3 cr. (Not offered every year.)

Zoology

707. HUMAN GENETICS
Inheritance patterns, gene and chromosome mutation rates and effects, linkage, and gene frequency. Prereq: principles of genetics or permission. 4 cr.

History (Hist)

Chairperson: Charles E. Clark

ASSOCIATE PROFESSORS: Robert C. Gilmore, Marion E. James, Allen B. Linden, Frank D. McCann, Marc L. Schwarz, Harvard Sitkoff, John O. Voll
ASSISTANT PROFESSORS: Jeffry Diefendorf, Judith A. Silver
DIRECTOR OF GRADUATE STUDIES: Donald J. Wilcox

Admission

The department usually requires completion of an undergraduate level of eight semester courses in history together with some preparation in other areas of the humanities and social sciences.

Applicants for admission to any graduate program in history should have a minimum of B+ average in history and allied humanities and social sciences. In addition applicants must submit Aptitude (verbal and quantitative) and Advanced History scores on the Graduate Record Examinations. The department assesses the student's entire application, including letters of recommendation, in making its decision on admission. Deficiencies in an undergraduate program may be rectified by course work as a special student but such coursework cannot be used to satisfy requirements for an advanced degree. The department also recommends that a beginning graduate student have some training in a foreign language. It should be noted that students who expect to participate in seminar or reading courses in other than American history are usually required to have a reading knowledge of at least one foreign language appropriate to the particular course. Applicants intending the Ph.D. degree should include with their applications a personal statement indicating their reason for and intentions in undertaking graduate study at the University of New Hampshire.

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

Degree Programs

The department offers the Master of Arts and Doctor of Philosophy degrees. The general degree requirements are outlined below, but specific programs are tailored to the goals of the student. The director of graduate studies of the department serves as the initial adviser to entering graduate students, the adviser-of-record to all students throughout their years of graduate study, and, with the Graduate Committee of the department, has general supervision of all student programs. By the beginning of a student's second semester in residence, the student intending a degree will ordinarily have selected a single member of the faculty as the program chairperson and, with that faculty member as principal adviser, will have worked out a specific program of studies leading toward a degree.

The director of graduate studies must approve the registration of special students and students from other departments in graduate history courses. The department welcomes the opportunity to work with students from other departments.

Master of Arts

The student intending the M.A. degree has the choice of designing a specific program to meet either of two sets of requirements; the first allows substantial training and research in a single subfield of history but within a foundation of broader coursework; the second allows substantial breadth over at least two subfields. The subfields in history are as follows: the Ancient World; Medieval Europe; Early Modern Europe; Modern Europe; European Intellectual History; Medieval England; Early Modern England; Modern England; Iberian History; Russia; Early American History; Modern American History; Colonial Latin America; Modern Latin America; the Far East; the Near East; Sub-Saharan Africa; and the History of Science.

Completion of the degree under either set of requirements normally requires between three and four semesters of full-time study (three to four courses per semester). Either plan may prepare a student for en-
trance to the Ph.D. program. Plan B is particularly recommended for practicing teachers.

Plan A: The student shall complete successfully at least eight courses in history numbered above 700, of which a minimum of four shall be numbered between 800 and 898 (seminar and directed readings). In addition, the student shall prepare within the context of any single subfield a thesis meriting the unanimous approval of a thesis committee consisting of the student's program chairperson, under whose direction the thesis shall be prepared, and two other members of the graduate faculty (at least one of them in history). The preparation of the thesis is considered to be the equivalent of two additional semester courses each bearing the designation History 899 for the purpose of meeting the general regulations of the Graduate School.

Plan B: The student shall complete successfully at least ten courses in history numbered above 700 of which a minimum of four shall be numbered between 800 and 898. Following completion of coursework or during the final semester of coursework, the student shall demonstrate a broad competence in two subfields of history ordinarily in oral examination before a committee of three consisting of the student's program chairperson and two other members of the faculty in history. Students proceeding under Plan B shall have stood examination no less than three weeks prior to the Commencement at which the degree is to be granted.

Students should note that Plan A thesis readings and Plan B examinations are available during the summer, only with the consent of all faculty involved.

Doctor of Philosophy

The department offers work leading toward the degree of Doctor of Philosophy with a concentration in either of the two subfields of American history, but with particular stress on Early American history. The degree requires more than formal coursework; it is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examinations and by preparation and defense of a dissertation. Normally an entering student intending to be a candidate for the doctorate will complete an M.A. program as a prerequisite. Students with the M.A. from another institution, however, can begin the doctoral program immediately, and a student in residence can, with the consent of the department, omit the M.A. and proceed directly toward the Ph.D.

The doctoral student's cardinal intellectual relationship is with that member of the faculty under whom he/she will write the dissertation and who serves as the student's program chairperson. This relationship should be established early and a broad program supportive of the intended area of dissertation research worked out in consultation with the program chairperson. The program, which must be approved by the Graduate Committee of the department, shall involve each of the following:

1) Two required research seminars in American history, one in early America and one in modern America.

The history department offers these required research seminars in the first semester of each year, alternating between the two fields. Each entering student, with or without the M.A., should take one in each of the first two years in the program. Other seminars and reading courses at the 800 level will also form part of the program drawn up in consultation with the student's program chairperson.

2) Required courses in historiography and historical methods. The history department will offer one of these courses in the second semester of each year, alternating between the historiography course and the historical methods course. Each entering student, with or without the M.A., should take one in each of the first two years in the program.

Note: No student will be considered to be intending to pursue a Ph.D. program who is not in the process of satisfying these requirements. Only students who are intending to pursue the Ph.D. are considered for graduate assistantships.

3) Two languages or one language and a special research technique, whichever is deemed most relevant to the area of research.

4) The entirety of American history, with accent upon either of the subfields of early or modern America, and two subfields outside of American history.

5) A cognate field outside of history entirely or a subfield of nonwestern history.

The student's preparation for the qualifying examinations will be guided by representatives of each subfield or cognate field in his/her program. These representatives will make up the student's guidance and, subsequently, examining and dissertation committees. The student will normally not take the qualifying examination until he/she has completed sixteen semester courses or more (including work undertaken in a master's program). This requires three years of study beyond the bachelor's degree, the greater portion of which is ordinarily accomplished in full residence. The student should bear in mind, however, that qualifying examinations will test a mastery of broad subfields of historical knowledge rather than of particular courses. The student is, therefore, expected to read widely and independently in order to expand his/her knowledge beyond formal coursework and to become acquainted with aspects of the subfields not covered in that coursework.

Normally there will be eight steps in attaining the degree. Students are expected to be registered in the University for all regular academic semesters during their progress.

1) Satisfaction of historiography, historical methods, and research seminar requirements.
History

2) Correction of any deficiencies in the student's previous program, for example, lack of a first language.

3) The demonstration of proficiency in a second language or a special research technique. (Departmental regulations regarding the latter are available from the director of graduate studies.)

4) Successful performance in a two-part qualifying examination: the first part, a four-hour written examination covering breadth of knowledge in the subfield of specialization (early or modern American history); the second part, oral and covering all subfields and (if any) the cognate field specified in the program.

5) Within the same semester as Step Three, admission to candidacy and the approval by the candidate's dissertation committee of the specified topic and research plan for the dissertation.

6) Submission of an acceptable dissertation no more than three years after the admission to candidacy.

7) Successful public defense of the dissertation before the dissertation committee.

8) Formal submission of the dissertation to the department and Graduate School at least two weeks prior to the commencement at which the degree is to be conferred.

Apprenticeship

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

703. THE COLONIAL PERIOD OF AMERICAN HISTORY
Interpretative and methodological approach to the development of an Anglo-American culture along the eastern seaboard of North America 1600-1750. 4 cr.

705, 706. AMERICA IN THE 18th CENTURY AND THE REVOLUTION
American colonial and revolutionary history from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. 4 cr.

711, 712. NINETEENTH CENTURY AMERICA
Domestic and international factors in the development of the American republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. 4 cr.

715, 716. TWENTIETH CENTURY AMERICA
The United States after 1900, with emphasis on the cultural, political, and social factors causing major changes in American life. 715: Progressivism through the New Deal. 716: World War II to the present. 4 cr.

719, 720. THE FOREIGN RELATIONS OF THE UNITED STATES
Primarily the history of American diplomacy, with attention given to the nondiplomatic aspects. 719: American Revolution to 1890; 720: 1890 to date. 4 cr.

721, 722. HISTORY OF AMERICAN THOUGHT
Significant American thinkers considered in their social context. 721: 1600 to 1860. 722: 1860 to the present. 4 cr. (Not offered every year.)

724. AMERICAN URBAN HISTORY
The urbanization process from the colonial period to the present. 4 cr.

731. LATIN AMERICAN HISTORY: REGIONAL OR COUNTRY STUDIES
Seminar; readings and discussions of literature relative to region or country being studied. See department listing for the current semester's topic. Students will be guided through preparation of a research proposal. Latin American History recommended but not required. 4 cr.

732. LATIN AMERICAN HISTORY: TOPICAL STUDIES
Thematic seminar; readings and discussions of literature relative to topic selected. See the department listing for the current semester. Students will be guided through preparation of a research proposal. Latin American History recommended but not required. 4 cr.

739, 740. THREE MEDIEVAL CIVILIZATIONS
The 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.

741. THE AGE OF THE RENAISSANCE
The Renaissance from 1300 to 1600 stressing intellectual and cultural history and concentrating on events in Italy. 4 cr.
742. THE AGE OF REFORMATION  
Northern Europe from 1300 to 1600, stressing the intellectual and cultural aspects of the European Reformation. Concentrates on the 16th century but important trends in the 14th and 15th centuries given considerable attention. 4 cr.

747. FRANCE FROM LOUIS XIV TO THE FRENCH REVOLUTION  
Pressures and influences which led to the French Revolution. 4 cr.

748. NINETEENTH CENTURY EUROPE  
Impact of the Industrial Revolution and the French Revolution on the workers, peasants, middle class, and women of England, France, and Germany. 4 cr.

751, 752. EUROPEAN INTELLECTUAL HISTORY  
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. (Not offered every year.)

756. 20th CENTURY EUROPE  
World War I, European totalitarians, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

759. HISTORY OF MODERN SPAIN AND PORTUGAL  
Iberian states and their peoples from the coming of liberalism to the present. Failure of Iberian liberalism and liberal government. Political and social change, imperial and intellectual movements, influences of Western European thought and activity. 4 cr.

761, 762. ENGLAND IN THE TUDOR AND STUART PERIODS  
Political, religious, socio-economic, and intellectual forces for change at work in England from the accession of Henry VII to the Revolution of 1688-89. 4 cr.

763. RUSSIA: ORIGINS TO MODERNIZATION  
Russia from its foundation to Emancipation and Reform. Political developments, foreign relations, intellectual and ideological currents. 4 cr.

764. RUSSIA: FROM TSARIST TO SOVIET EMPIRE  
Costs of modernization; Leninist and Stalinist revolutions; Soviet consolidation. 4 cr.

767. EARLY MODERN GERMANY: REFORMATION TO THE REVOLUTION OF 1848  
Conflict between Holy Roman Empire and petty states; rise of Prussia; religious conflict and Enlightenment. 4 cr.

768. MODERN GERMANY SINCE 1848  
Bismarck and Imperial Germany; Weimar and the rise of Hitler; post-World War II divided Germany. 4 cr.

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

775. HISTORICAL METHODS  
Introduction to contemporary historical methods. Required of all entering Ph.D. candidates, open to undergraduates with permission. 4 cr. (Not offered every year.)

777, 778. THE HELLENISTIC-ROMAN WORLD  
The Mediterranean and the Near East from the death of Alexander the Great to the collapse of the Roman and Persian Empires (5th to 7th centuries A.D.). Covers the main political and social developments of the area, but stresses artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity, Zoroastrianism, and the general religious climate that prepared the way for Islam. 4 cr.

781. HISTORY OF MODERN CHINA, 1839-PRESENT  
The modernization of China. The political, social, and cultural changes which have occurred in China from its early contacts with the West. 4 cr.

784. HISTORY OF SOUTHERN AFRICA SINCE 1820  
The struggle for political and economic control in the only region of Africa where European groups remain in power. The impact of European imperialism, European settler nationalism, racial conflict, economic competition and industrialization, apartheid, and assimilation with special attention to the development of European hegemony. Official American policy. 4 cr.

785. THE MODERN MIDDLE EAST  
From the 18th century to the present time. The problems created by modernization and reform of the traditional society, the conservative reaction to reform, the impact of nationalism, and the appearance of new ideologies. 4 cr.

787. BLACK CONSCIOUSNESS AND PROTEST  
Origins and causes of the rising consciousness and consequent activism of the peoples of Negro descent in the New World and in Africa from the early nineteenth century to the present. Protest literature, black nationalism, Pan-Negroism, Pan-Africanism, negritude, the Nation of Islam, and separatist religious sects in the Americas and Africa. Crosscultural and multidisciplinary. 4 cr.
789. SEMINAR IN THE HISTORY OF SCIENCE
Selected topics conducted through special lectures, individual study, oral and written reports. Subject varies. Cannot be used for credit in history without permission of the department. Prereq: permission of adviser and instructor. 4 cr.

790. QUANTIFICATION AND COMPUTERS FOR THE HISTORIAN
The historian's use of computers and statistics; practical applications of both interactive terminal operations and batch processing. Data generation and processing, computer languages (BASIC, FORTRAN), programming and library programs, elementary statistics; students will undertake operations of their own on material supplied and will consider particular quantitative studies in history in terms of techniques used. No previous knowledge of computers or college mathematics required. Prereq: admission as an undergraduate major or graduate student in history/or permission. 4 cr.

793. ADVANCED WORLD HISTORY
History from the perspective of the experience of the whole human community. The histories of separate areas in terms of their relationship to the general historical experience of man. Problems of interpretation, interrelationships, similarities, and differences in the development of the major traditions of civilization. Oral and written reports. 4 cr.

797. COLLOQUIA IN HISTORY
Selected topics in American, European, and non-Western history. Open to advanced undergraduate and graduate students. Prereq: permission. Depending on the particular subject, may be used to satisfy the major requirements in American, European, or non-Western history. 4 cr.

Graduate Readings and Seminars

Note that in any given semester any number of sections of a general seminar course (819 through 860) may be offered, the content and direction of a specific section depending upon the research interests of the faculty member directing the section. General seminar and reading courses, and particular sections, can be repeated as the section content changes. A full description of the current direction and content of each section offered in a given semester is available shortly before the semester from the department's director of graduate studies.

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. No cr.

819, 820. SEMINAR IN EARLY AMERICAN HISTORY
1) Mr. Clark (social and cultural), 2) Mr. Gilmore (Revolution), 3) Mr. Rutman (Anglo-American society). Prereq: permission. 3 cr.

823, 824. SEMINAR IN AMERICAN NATIONAL HISTORY
1) (Afro-American), 2) Mr. Sitkoff (twentieth century), 3) Mr. Jellison (nineteenth century and biography), 4) Mr. Mennel (social), 5) Mr. Long (foreign relations). Prereq: permission. 3 cr.

836. SEMINAR IN LATIN AMERICAN HISTORY
Topics will vary and will include: conservatism and conformity in Latin America; the Portuguese Empire; Brazil and Africa; the Mexican Revolution; nationalism and neocolonial Latin America; Brazil: empire and republic; and slavery in the Americas: a comparison. Mr. McCann. 3 cr.

843, 844. SEMINAR/READINGS IN EUROPEAN HISTORY
1) Mr. Heilbroner (modern Russia). 2) Mr. Jones (Medieval). 3) Ms. Silver (France and European social history). 4) Mr. Wheeler (Spain and Portugal). 5) Mr. Wilcox (Renaissance). 3 cr.

859, 860. SEMINAR IN ENGLISH HISTORY
1) Mr. Schwarz (Tudor-Stuart). Prereq: permission. 3 cr.

888. PROBLEMS IN MODERN AFRICAN HISTORY
Topics will vary each year the seminar is offered. Emphasis will be on Africa south of the Sahara in the colonial and postcolonial eras. Among the topics will be: African resistance movements in precolonial and colonial Africa; African nationalism; problems of the independent African states; the role of the military in postcolonial Africa; and issues in Portuguese African history. Students will write research papers and give oral presentations. Mr. Wheeler. 3 cr.

895, 896. TUTORIAL READING AND RESEARCH IN HISTORY

899. MASTER'S THESIS

999. DOCTORAL RESEARCH
Home Economics (HEc)

Chairperson: Elizabeth Snell

ASSOCIATE PROFESSORS: Mary E. Holder, Victor R. Messier, Elizabeth A. Snell
ASSISTANT PROFESSORS: Larry J. Hansen, Sharon F. Young

The department offers graduate work leading to a Master of Science degree in home economics, with the major emphasis in areas which strengthen professional competence in family, community, and educational services. Each student's program will be planned to achieve professional objectives based on specific interests, ability, and undergraduate preparation.

Admission: Students admitted to the graduate program in home economics are expected to have an undergraduate degree in home economics or a related field. If there are deficiencies in the undergraduate program, students may be admitted on condition that they complete specified prerequisites which will not be counted toward the degree. Students seeking admission must submit recent scores from the Miller's Analogies Test or the Aptitude section of the Graduate Record Examination.

Requirements: A candidate for a Master of Science in home economics is expected to fulfill the general requirements of the Graduate School and the following departmental requirements:

1) A minimum of 22 semester credits in home economics courses including Research Seminar, HEc 897; and Research Project, HEc 898, or Thesis, HEc 899.
2) A maximum of 8 semester credits selected from the liberal arts or other areas which support the major may be applied toward the degree.
3) Before the second semester of graduate study the student will have planned a program of studies with the approval of his/her advisory committee.
4) A final oral and/or written examination.

707. PRACTICUM IN HOME ECONOMICS
Supervised in-depth experience with observation and participation to increase the student's understanding in a specific area of home economics. Choice of practicum from areas of: 1) child; 2) family; 3) consumer; 4) food and nutrition studies. Prereq: HEc major; permission. 4 cr.

709. BIOCHEMISTRY OF NUTRITION
Intermediary metabolism of nutrients and energy; metabolism transport mechanisms; biological oxidations; interrelationships of carbohydrate, fat, and protein metabolism; obesity; control of hunger and appetite. Prereq: college course in biochemistry. (Also offered as AnSc 709.) 4 cr.

715. CLOTHING IN RELATION TO HUMAN BEHAVIOR
Research and theory in the social psychological aspects of clothing; clothing behavior of individuals and groups; stages of the life cycle, development of the self, and the phenomenon of fashion. 4 cr.

725. PRESCHOOL PROGRAMS
Organization of time, space, materials, and people for the purpose of attaining goals in preschool education. Historical and current programs will be studied. Prereq: Preschool Methods and Materials or permission. 4 cr.

727. STUDENT TEACHING IN PRESCHOOL
Supervised teaching experience in a selected preschool; 18-20 hours per week. Bi-weekly seminar on campus. Prereq: HEc major; permission. 6 cr. Cr/F.

754. PERSONAL AND FAMILY FINANCE
Financial alternatives available to individuals and families during stages of the family life cycle. 4 cr.

756. CONSUMER PROTECTION
Types of protection available to consumers; investigation and evaluation of the structure and operating procedures of regulatory agencies. Prereq: permission. 4 cr.

774. CLINICAL DIETETICS
Principles of normal nutrition applied to clinical problems; altered nutrient requirements in human disease. Diet therapy as applied to clinical nutrition. Prereq: Principles of Nutrition; Human Nutrition; biochemistry; permission. 4 cr.

776. CONTEMPORARY ISSUES IN NUTRITION
National and worldwide nutrition concerns. Approaches and materials used in nutrition education. Prereq: basic nutrition course or permission. 4 cr.
786. **DYNAMICS OF FAMILY CHANGE**
Theories and research for the assessment of family interaction patterns; planned intervention techniques. Students examine their interaction processes and their possible effect on intervention efforts. Prereq: Family Relations; Clinical Approaches to Human Behavior. 4 cr.

791. **METHODS OF TEACHING HOME ECONOMICS**
Home economics in the school program; curriculum materials, methods, and resources in teaching. 4 cr.

793. **FAMILY LIFE EDUCATION**
Review of current issues and literature; materials and methods for programs such as sex education and parent education. Prereq: Human Reproductive Biology; Family Relations; permission. 4 cr.

883. **AMERICAN FAMILIES IN POVERTY**
Problems of economically-deprived rural and urban families. Objective, intellectual, and human involvement in dealing with poor families. Understanding the strengths and weaknesses typical of American families in poverty. 4 cr.

886. **CRITICAL PROBLEMS IN FAMILY LIFE**
Evaluation of the needs and resources of families with critical problems; maturational and situational sources of stress influencing the contemporary American family; students will demonstrate mastery of theoretical concepts by developing self-help strategies to be used by families experiencing stress. Prereq: permission. 4 cr.

893. **PARENTS AND CHILDREN**
In-depth study of the reciprocal relationships among parents and children. Evaluation of service programs in terms of current research. Prereq: the Young Child, Family Relations, or permission of instructor. 4 cr.

895. **SEMINAR AND SPECIAL PROBLEMS**
The seminars are open to graduate students with sufficient background for in-depth study in any of the following areas: A) clothing and textiles, B) consumer education, C) family relations, D) food and nutrition, E) home economics education, F) management and family finance, and G) human development. The student will contribute to a selective review and critical evaluation of the research and current literature and an examination of issues and trends. Independent projects may be a part of the experience. These seminars will not be scheduled every semester. One or more semesters, maximum of 4 credits in one area. 2 to 4 cr.

897. **RESEARCH SEMINAR**
Survey, evaluation, and use of research in the field of home economics. Methods and techniques used in defining a problem for study, collecting data, analyzing, and writing a report. 2 cr.

898. **RESEARCH PROJECT**
A study or project which may be selected in lieu of a thesis. To be taken concurrently with or following HEc 897. 2-4 cr.

899. **Thesis**
6 cr.

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**Institute of Natural and Environmental Resources**

**Director:** David P. Olson  
**Chairperson of Graduate Studies:** Robert D. Harter

**ADJUNCT PROFESSORS:** George E. Frick, Nelson L. LeRay, Douglas E. Morris  
**ASSOCIATE PROFESSORS:** Robert D. Harter, Edmund F. Jansen, Jr., William W. Mautz, David P. Olson, Nobel K. Peterson, R. Marcel Reeves, Oliver P. Wallace, Sr., Richard R. Weyrick  
**ADJUNCT ASSOCIATE PROFESSORS:** C. Anthony Federer, William B. Leak, Robert S. Pierce  
**ASSISTANT PROFESSORS:** W. Thomas Adams, John E. Carroll, S. Lawrence Dingman, Peter H. Greenwood, Bruce E. Lindsay, Albert E. Luloff, Donald R. Miller, Kurt N. Olson  
**ADJUNCT ASSISTANT PROFESSOR:** Peter W. Garrett

**Master of Science, Natural and Environmental Resources**

A single master's degree is offered by the Institute with six specific options:

**Forest Resources:** Forest resource management; forest recreation; forest marketing; wood industry management; forest mensuration; forest tree improvement; and wood science and technology.

**Hydrology:** Hydrochemistry; ground water hydrology; surface water; and water resource management.
Resource Economics: Agricultural economics; community development; regional economics; land and water economics; rural manpower; and marine economics.

Soil Science: Soil chemistry; soil classification and genesis; soil microbiology; and forest soils.

Resource Administration and Management: Management of publicly and privately owned natural resources; administration of natural resource laws and policies; management of natural resource based firms.

Wildlife Ecology: Habitat evaluation and management; wildlife nutrition and physiology; and land-use planning for wildlife.

Entrance requirements

Students admitted to Institute programs in these options are expected to have completed either an undergraduate degree in the field in which they plan to specialize or show adequate preparation in the basic support courses of the field. Students with good undergraduate records who lack a background in a particular field may be admitted to a program, provided they are prepared to correct the deficiencies. The Graduate Record Examination is required of all applicants.

Students entering the forest resources option 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 planning for the resource economics option will need satisfactory undergraduate training that includes four or more courses in economics or resource economics. Entering students in hydrology and soil science are required to have adequate preparation in chemistry, physics, mathematics, and the biological or earth sciences. Students interested in wildlife ecology are expected to have adequate preparation in biological sciences, chemistry, and mathematics including statistics. Students interested in resource administration and management are expected to have had a minimum of three courses in the areas of ecology or natural resources, and resource economics, or be expected to make up this deficiency.

Academic Requirements

The M.S. degree is conferred upon successful completion of the following:

1) A program amounting to not less than 30 credits (34 credits for Res. Admin. and Mgt.), including the following course requirements or equivalent: INER 893-894 seminar, 2 credits; INER 803, Approach to Research, 2 cr.; quantitative methods or analytical techniques; and

INER 898, Directed Research, 4-6 cr. or INER 899, Thesis, 6-10 cr.

2) A final oral and/or written examination.

Intercollegiate Cooperative Programs

The Institute participates in four doctoral degree programs on a cooperative basis with other departments in the University. The Department of Chemistry offers a soil and water chemistry option in its Ph.D. program, which is coordinated through joint efforts of the soils and hydrology faculties and the chemistry faculty (see Interdisciplinary Options and Programs). A Ph.D. program in genetics is available to students in forest resources through the Genetics Program (see Genetics Program). Students can earn a Ph.D. in economics in the cooperative program with resource economics and the Whittemore School of Business and Economics (see Economics). Through informal cooperative arrangements with the electrical and computer engineering and mechanical engineering departments, opportunities are available for graduate study in wood science and technology in the College of Engineering and Physical Sciences, leading to either the master's degree in electrical engineering or mechanical engineering or the Ph.D. degree in engineering. (See Engineering Ph.D. Program: Theoretical and Applied Mechanics or Signal Processing.)

Natural and Environmental Resources (INER)

701. STATISTICAL METHODS I
Analysis of variance and general linear models; measured numbers, the nature of statistical evidence, sampling distributions, and principles of statistical inference; application of specific linear models to given sets of data. Prereq: upper-division undergraduate or graduate standing. Mr. Durgin. 4 cr.

702. NATURAL RESOURCES POLICY
Contemporary issues in the management and allocation of natural resources; impact of man on agricultural and forest lands, water, wildlife, fisheries, and minerals; historical perspective of current resource policies. Prereq: permission. Mr. Bruns. 4 cr.

709. SOILS AND COMMUNITY PLANNING
Using a town plan and soils map, students develop reports for multiple urban and rural land-use—housing, sewage, recreation, transportation, runoff, etc. USDA soil classification system; Soil Conservation Service rating criteria; New Hampshire soils. Guest lecturers. Prereq: permission. Mr. Peterson. 2 cr.
711. **STATISTICAL METHODS II**
Intermediate course in statistics; basic concepts of sampling, linear models, and analyses for one-way and multiway classification, factorial arrangements of treatments, multiple regression, and covariance. Prereq: Applied Statistics I or equivalent. Mr. Barrett. 4 cr.

712. **SAMPLING TECHNIQUES**
The 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. Computer programs used in analyzing data. Examples taken from the environmental sciences. Prereq: Applied Statistics I or equivalent. Mr. Barrett. 2-4 cr.

714. **QUANTITATIVE ECOLOGY**
Applied quantitative techniques: basic concepts in probability and statistics applied to ecological systems, population dynamics, spatial patterns, species and abundance and diversity, classification and ordination, production, and energy and nutrient flow. Additional credit for in-depth mathematical analysis of a particular topic. Prereq: introductory calculus, statistics, and ecology. Mr. Barrett. 3 or 4 cr.

718. **LAW OF NATURAL RESOURCES AND ENVIRONMENT**
For resource managers: the legal system pertaining to resource management, protection of the environment, and possibilities for future action. Prereq: Contemporary Conservation Issues or Land Economics and Use/or permission. Mr. Tucker. 3 cr.

757. **BASICS OF REMOTE SENSING**
Application of photographic and nonphotographic sensors to information gathering in natural resource fields; interpretation of aerial photographs. Applications to forestry, wildlife, land-use planning, earth sciences, soils, hydrology, and engineering. Mr. Bruns. Lab. 2 cr.

758. **APPLICATIONS OF REMOTE SENSING**
Student project is developed using available conventional aerial photography or other imagery. Transportation fee. Prereq: Basic Remote Sensing; permission. Mr. Olson. Lab. 2 cr.

795, 796. **INVESTIGATIONS IN:**
A) Resource Administration; B) Resource Management; C) Resource Policy; D) Public Laws and Resources. May be repeated. Prereq: permission. 2-4 cr.

797. **FOREST RECREATION SEMINAR**
Recreational use of nonurban lands; economics of public and private developments; planning for state and private recreational use, social aspects. Class project. Prereq: junior standing; permission. Mr. Wallace. 4 cr.

803. **APPROACH TO RESEARCH**
The meaning of science and the application of logic in the scientific method. Principles and techniques of scientific research. Survey of experimental design procedures. Organization of investigative work, problem analyses, working plans, and scientific writing. Prereq: permission. 2 cr.

811. **NATURAL AND ENVIRONMENTAL RESOURCE MANAGEMENT**
To develop an understanding of the fundamental scientific, aesthetic, and ethical principles involved in the management of renewable natural resources and ways to apply these principles in the formulation and evaluation of resource-management policies including the identification of unifying concepts in the management of specific renewable resources, soils, water, forests, and wildlife. Prereq: permission. Mr. Dingman. 4 cr.

812. **ADMINISTRATION OF RESOURCE LAWS AND POLICIES**
Largely devoted to legalistic, policy, and political science aspects of natural and community resource administration. Attention is also given to concepts of private property, home rule, social value, tradeoffs, and bureaucracy as elements in administration. Transportation fee. Prereq: permission. Mr. Carroll. 4 cr.

815. **LINEAR PROGRAMMING METHODS**
Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications; nonlinear programming, discrete programming; and solving input-output and game-theory problems. Prereq: Elementary Matrix Algebra or permission. Mr. Andrews. 2 cr.

816. **QUANTITATIVE-FOREST ECOLOGY SEMINAR**
Preparation, presentation, and discussion of recent topics in quantitative ecology such as remote sensing, population growth, competition between species, modeling of a population, and energy flow. Seminar is 2 credits; an additional 2 credits available for an indepth study of a particular topic. Mr. Leak and Mr. Barrett. 2-4 cr.
893, 894. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR
Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. May be repeated. 1 cr. Cr/F.

898. DIRECTED RESEARCH
Hours and credits to be arranged. Prerequisite: permission. Not available if credit obtained for INER 899. 2-6 cr. (Continuous course; "IA" grade given.) Cr/F.

899. THESIS
Hours and credits to be arranged. Prerequisite: permission. 3-10 cr.

Forest Resources (FoRs)

720. FOREST GENETICS
The genetics of forest tree improvement with emphasis on variation in natural populations, evolutionary principles, and breeding methods. Lab. Prerequisite: Principles of Genetics; Silviculture/or permission. Mr. Adams. Transportation fee. 3 cr. (Offered spring 1978-79.)

722. ADVANCED SILVICULTURE
Intensive silviculture of forest stands. Artificial regeneration (e.g., alternative regeneration methods and site preparation); plantation management (e.g., thinning schedules and fertilization). Transportation fee. Prerequisite: Silviculture; permission. Mr. Adams and Mr. Hocker. 4 cr. (Offered spring 1978-79.)

734. FOREST PROTECTION SEMINAR
Discussion and special problems based on principles and techniques of forest protection. Prerequisite: Forest Fire Protection or courses in entomology or plant pathology. Mr. Weyrick. 3 cr.

737. GAME MANAGEMENT I
Biological characteristics, habitat requirements, research and management practices of upland game birds and big game animals. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prerequisite: wildlife management major or permission. Mr. Mautz. Lab. 4 cr.

738. GAME MANAGEMENT II
Biological characteristics, habitat requirements, research and management practices of small game animals, furbearers, predators, and waterfowl. Several all-day field trips required (possibly on weekends) to New England wildlife areas. Transportation fee. Prerequisite: wildlife management major or permission. Mr. Miller. Lab. 4 cr.

745. FOREST MANAGEMENT
Production control; management objectives; forest production regulation and economic analysis; forest administration; professional responsibilities and opportunities. Lab. Prerequisite: completion of junior year in forestry curriculum. Transportation fee. Mr. Weyrick. 4 cr.

753. OPERATIONS CONTROL AND ANALYSIS
Some quantitative tools for decision making in forest resource management activities; development and analysis of cost functions, timber and stumpage valuation, forecasting, linear programming, Monte Carlo simulation, PERT. Lab. Prerequisite: Calculus; Forest Economics; Statistics; Mensuration. Mr. Foster. 4 cr.

754. WOOD PRODUCTS MANUFACTURE AND MARKETING
Wood products from harvesting and procurement of raw material to finished product processes; management decisions, marketing, and promotion problems. Visits to harvesting operations and manufacturing plants in New England. Lab. Transportation fee. Prerequisite: Wood Technology/or permission. Mr. Hill. 4 cr.

764/864. FOREST INDUSTRY ECONOMICS
Business methods and economics in the forest industry; planning for minimum cost operations and profitable use of capital in a forest enterprise. Individual projects. Prerequisite: senior standing; permission. Mr. Wallace. 4 cr.

798. FOREST RESOURCES MANAGEMENT SEMINAR
Population trends and human needs in relation to forest land productivity for timber, wildlife, water, recreation, and grazing. Class organized for group planning to maximize forest productivity for the state of New Hampshire. Prerequisite: Forest Management. Mr. Wallace. 4 cr.

801. FOREST MANAGEMENT SEMINAR
Seminar discussions of current literature, plans, principles, and new developments in the general field of forest management. Transportation fee. Prerequisite: permission. Mr. Bruns and others. 2 cr.

805. UTILIZATION SEMINAR
Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Prerequisite: permission. Mr. Hill. 2 cr.

806. OPERATIONS CONTROL SEMINAR
Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of quantitative control of forest operations. Prerequisite: permission. Mr. Foster. 2 cr. (Not offered every year.)
809, 810. WILDLIFE MANAGEMENT SEMINAR
Discussions and assigned reports on current investigations and developments in wildlife management. Prereq: undergraduate courses in wildlife management. Mr. Olson, Mr. Mautz, and Mr. Miller. Variable 1-4 cr.

895, 896. INVESTIGATIONS IN: A) FOREST ECOLOGY; B) REMOTE SENSING; C) WOOD UTILIZATION; D) GAME MANAGEMENT; E) MENSURATION; F) FOREST ECONOMICS; G) FOREST MANAGEMENT; H) OPERATIONS CONTROL AND ANALYSIS; I) RECREATION; J) POLICY; K) WILDLIFE PHYSIOLOGY
Elective only after consultation with the instructor in charge. 1-4 cr.

Hydrology (Hydr)

705. 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 interception and streamflow, snow-melt, evapotranspiration, 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: calculus. Mr. Dingman. 4 cr.

710. GROUNDWATER HYDROLOGY
Principles governing occurrence, location, and development of groundwater; principles of fluid flow, well hydraulics, regional flow, geophysical exploration, and chemical quality of water; use of fluid and mathematical models and selected problems. Lab. Prereq: physics; geology; calculus. Mr. Hall. 4 cr.

795, 796. INDEPENDENT WORK IN HYDROLOGY
A) Hydrology; B) Chemistry of Water; C) Water Resource Management. Student may choose topic and faculty consultant. 1-4 cr.

803. ADVANCED HYDROLOGY
Application of quantitative methods to selected hydrologic problems. Critical examination of deterministic and stochastic models, with emphasis on conceptualizing the hydrologic problem, developing appropriate models, obtaining solutions, and evaluating models and solutions in terms of basic assumptions, data requirements, and verification of results. Prereq: Principles of Hydrology; Computer Methods; Basic Statistics. Mr. Hall, Mr. Dingman. 3 cr.

804. HYDROCHEMISTRY
Chemical principles for dilute aqueous solutions at relatively low temperatures and pressures are applied to the study of fresh waters at or near the earth's surface. Major topics: equilibrium concepts, buffering mechanisms, oxidation-reduction reactions, and ion exchange. Emphasis is given to selected systems involving water, carbon dioxide, calcium carbonate, and silicate minerals. Laboratory exercises utilize simple experiments to give experience with methods of measurement and interpretation of results. Lab. Prereq: two years of chemistry or equivalent/or permission. Mr. Hall. 3 cr.

808. WATER RESOURCE MANAGEMENT
Hydrologic and statistical aspects of water resource management; nature of water-resource problems and application of models in their solution; geographical aspects of water-resource problems in the U.S.; economic, social, institutional, and environmental aspects of water-resource problems. Prereq: Principles of Hydrology; Basic Statistics/or permission. Mr. Dingman. 4 cr.

895-896. INVESTIGATIONS IN: A) Hydrology; B) Chemistry of Water; C) Water Resource Management. Elective only after consultation with the instructor in charge. 1-4 cr.

Resource Economics (REco)

705. PLANNED CHANGE IN NONURBAN COMMUNITIES—APPLICATION
Application of community development theory and principles using appropriate research methodologies. Students participate in community development activities, discuss problems and report on experience and progress in weekly seminars. May include placement in field agency. Prereq: Applied Community Development or permission. Mr. Luloff. 4 cr.

706. ECONOMICS OF RESOURCE DEVELOPMENT
Resource scarcity and theories of economic development and the major resource development problems of land and natural resources, urban-rural conflicting demands, and conservation and water supply; capital needs, externalities, and market failure, Prereq: intermediate microeconomic theory. Mr. Jansen. 4 cr.

710. RESOURCE ECONOMICS SEMINAR
A) Agricultural Economics and Food Policy; B) Rural Development; C) Marine Economics; D) Location of Economic Activity; E) Land and Water Economics; F) Quantitative Methods; G) Environmental Economics. Seminars arranged to student needs and as demand warrants. In-depth treatment including classic works. May be repeated. 2-4 cr.
717. LAW OF COMMUNITY PLANNING
Common law and the Constitution with respect to property law including eminent domain, land-use planning, urban renewal, and zoning. Makes the nonlawyer aware of the influence and operation of the legal system in community development. Mr. Tucker. 4 cr.

756. REGIONAL ECONOMIC ANALYSIS
Concepts and methods of delimiting regional economies, theories of growth, methods of measuring activity, regional development, and policies. Empirical research studies. Prereq: intermediate microeconomic theory or permission. Mr. Lindsay. 4 cr.

804. APPLIED ECONOMICS OF RESOURCE USE
The theory of resource allocation used in solving public and private economic problems. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, and uncertainty are analyzed with appropriate methodology. Primary emphasis will be placed on empirical research studies and their implications. Prereq: applied statistics; intermediate microeconomic analysis. 4 cr.

809. AGRICULTURAL ECONOMICS
Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decisionmaking in food production, marketing, and consumption; the competitive structure of the food industry. 4 cr.

820. ENVIRONMENTAL ECONOMICS SEMINAR
The use of economic concepts for analyzing current environmental problems. Student reports and class discussion will deal with the application of economic analysis to real world environmental problems at the local, state, and national levels; costs and benefits of alternative methods of dealing with environmental objectives; and other economic goals of society. Mr. Andrews, Mr. Jansen, and Mr. Henry. Prereq: intermediate micro- and macroeconomic analysis or equivalent; permission. 2 cr.

838. INTRODUCTION TO THE LOCATION OF ECONOMIC ACTIVITY
Economic theories explaining the behavior of individual firms and consumers in selecting sites for carrying on economic activities. The relationship of these theories to patterns of industrial location, systems of cities, and land-use competition in general. Problems of locational change and adjustment and the effects of public policy on spatial economic activities. Prereq: elementary calculus; linear algebra; regression; micro- and macroeconomics; or permission. 4 cr. (Not offered every year.)

Special assignments in readings, investigations, or field problems. May be repeated. Prereq: permission. Staff. 2-4 cr.

Soil Science (Soil)

701. PHYSICS OF SOILS
Soil as a physical system; textural and structural analysis of soils, water flow and retention, and heat and gas transfer; the physical properties of soil and plant growth; methods of soil physical analysis. Lab. Prereq: Soils and the Environment or permission. 4 cr.

702. CHEMISTRY OF SOILS
Chemical composition of soil; colloid phenomena and the exchange and fixation of elements; cation exchange capacity and source of negative charge; inorganic reactions in soil and their effect on soil properties. Prereq: one year of college chemistry or permission. Mr. Harter. 3 cr.

704. SOIL CLASSIFICATION AND MAPPING
Soil genesis, morphology, classification, and mapping; major classification systems used in the U.S. and throughout the world as they relate to human uses of the soil. Transportation fee. Prereq: Soils and the Environment; introductory geology/or permission. Mr. Peterson. 4 cr.

795, 796. INDEPENDENT WORK IN SOIL SCIENCE
A) Soil-Plant Relationships; B) Physics of Soils; C) Chemistry of Soils; D) Soil Classification. Prereq: permission. 2 cr.

802. CHEMISTRY OF SOIL COLLOIDS
Physical chemistry of soil colloids and colloidal phenomena. Electric double-layer theory, solid-solution interfacial reactions, surface acidity, theories of swelling, ionic diffusion. Prereq: permission. Mr. Harter. 3 cr.

895-896. INVESTIGATIONS IN:
A) SOIL-PLANT RELATIONSHIPS; B) PHYSICS OF SOILS; C) CHEMISTRY OF SOILS; D) SOIL CLASSIFICATION. Elective only after consultation with the instructor in charge. 1-4 cr.
Mathematics and Computer Science

Intercollege Course (Inco)

890. COLLEGE TEACHING
Acquisition of theoretical and practical knowledge of the basics of college teaching; the role of the college teacher in facilitating learning. Course participants will work to improve three aspects of their work: teaching methods with large and small groups, planning teaching sessions, and assessment of student learning. Participants will be encouraged to develop a teaching style that is effective and compatible with their philosophy, attitudes, and aptitudes. 2 cr.

Mathematics and Computer Science (Math)

Chairperson: M. Evans Munroe

ASSOCIATE PROFESSORS: Albert B. Bennett, Jr., William E. Bonnice, David M. Burton, Loren Meeker, Berrien Moore III, Albert O. Shar, Samuel D. Shore, Donovan Van Osdol
ASSISTANT PROFESSORS: R. Daniel Bergeron, Eugene Freuder, Marie Gaudard, William Geeslin, Robert Russell

The department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy.

Master of Science for Teachers

Admission Requirements: Completion of all requirements for secondary school teacher certification in mathematics.

Degree Requirements: 1) Ten semester courses approved by the department. These will normally be taken from the courses numbered 801-829 and will usually include the six courses numbered 803-808. 2) A comprehensive examination based primarily on material in courses 803-808. It is not possible to work full time during the academic year toward the Master of Science for Teachers degree. The courses in this program are offered primarily in summer institutes.

Master of Science in Mathematics

Admission Requirements: A year of abstract and linear algebra or a year of real analysis. Preference will be given to applicants who have completed both these sequences.

Degree Requirements: Ten semester courses approved by the department. These must be chosen from courses numbered 701-799 or 830-849. At least six of the ten must be from the 830-849 group. An oral comprehensive examination is based primarily on the courses taken.

Master of Science in Computer Science

Admission Requirements: High-level language programming, assembler language programming, data structures. Further experience in computer science, mathematics, and/or electrical engineering will also be expected.

Degree Requirements: Ten semester courses approved by the department. All must be numbered over 700 and six of the ten must be chosen from the following group: Math 850-859, Math 898J, Math 899 (may be used for two courses), EEE 860, 865. A master's thesis or project is required.

Doctor of Philosophy

The department offers the Ph.D. under two labels: mathematics and mathematics-education. (A detailed description of the Ph.D. program is available from the department.) These programs have a common core as follows:

Admission Requirements: same as for the Master of Science in Mathematics.

Basic Degree Requirements: 1) all of the courses numbered 833-839; 2) experience in teaching equivalent to at least half-time for one year; and 3) written comprehensive examination; this involves algebra, analysis (real and complex), and general topology, and should be taken after three semesters in residence.

Additional Degree Requirements for the Ph.D. in Mathematics: 4) proficiency in reading mathematical literature in two of three languages: French, German, and Russian; 5) advanced work in a major (the field of the thesis) and a minor (usually another field of mathematics or mathematics-education) with an oral examination in these two fields; and 6) thesis—with original and new mathematical results will be required. Thesis work is available in algebra, applied mathematics, 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; 6) thesis—new and original results involving pedagogical problems in mathematics will be required.

Courses numbered between 600 and 699 may be taken for graduate credit by nonmajors only.

611. ASSEMBLER LANGUAGE PROGRAMMING
Assembler-language coding and programming techniques. Data representation, systems organization, program segmentation, linkage of control sections, manipulation of bits or bytes, micro- and macroprogramming. Input/output using system macros. Interrupts. Prereq: intro. to comp. prog. 4 cr.

612. DATA STRUCTURES AND PROCESSES
Data structure programming techniques and program structure using a higher-level language such as PL/1. Linear lists, strings, arrays, trees, and graphs. Symbol tables, sorting and searching techniques. Data organization, record-oriented and stream-oriented data transmission conversion techniques, and storage allocation. Prereq: intro. to comp. prog. 4 cr.

636. PROBABILITY AND STATISTICS
Sample spaces (discrete only), events, combinations, conditional probability, independence, distributions, expectation, statistical description, random variables, sampling, estimation, tests, and applications. Credit toward a mathematics major only in mathematics-education. 4 cr.

644. APPLIED PROBABILITY AND STATISTICS
Introductory course for students in engineering, the physical sciences, interdisciplinary mathematics programs, and computer science. Prereq: calculus. 4 cr.

645. APPLIED LINEAR ALGEBRA
Applied matrix theory; eigenvalue problems and their applications in mathematics, physics, and engineering; systems of linear, ordinary, differential equations. Computer methods will be emphasized. Prereq: differential equations with linear algebra; multidimensional calculus; intro. to comp. prog. 4 cr.

646. ANALYSIS FOR APPLICATIONS
Initial-boundary-value problems of mathematical physics; Sturm-Liouville problems; series expansions by orthogonal functions; Green's functions; numerical methods. Prereq: differential equations with linear algebra; multidimensional calculus; intro. to comp. prog. 4 cr.

647. COMPLEX ANALYSIS FOR APPLICATIONS
Complex numbers; complex integration; infinite series; contour integration; conformal mapping; Fourier and Laplace transforms; Wiener-Hopf techniques. Prereq: multidimensional calculus. 4 cr.

656. INTRODUCTION TO NUMBER THEORY
Unique factorization, linear and quadratic congruences, quadratic reciprocity law, arithmetic functions, quadratic forms, an introduction to algebraic numbers. Prereq: introduction to abstract mathematics. 4 cr. (Not offered every year.)

657. GEOMETRY I
Advanced approach to fundamental properties of Euclidean geometry. Prereq: introduction to abstract mathematics. 4 cr.

658. GEOMETRY II
Systems of postulates of various geometries, geometric invariants, synthetic and analytic projective geometry, introduction to non-Euclidean geometry. Prereq: introduction to abstract mathematics. 4 cr. (Not offered every year.)

682. NONLINEAR DIFFERENTIAL EQUATIONS
Phase plane analysis of autonomous systems; critical points; limit cycles; periodic solutions; approximate methods for second-order nonlinear equations; stability and asymptotic behavior of solutions. Prereq: differential equations. 4 cr. (Not offered every year.)

A maximum of four of the following courses may be applied to the degree of Master of Science in mathematics or computer science.

710. ADVANCED PROGRAMMING SYSTEMS
Review of batch-process systems programs. Software organization; multiprogramming systems; techniques for parallel processing; multiaccessing and multiprocessing. Core management, file system design and management, and system accounting. Design of system modules and interfaces. Prereq: assembler language programming. 4 cr.

711. PROGRAMMING LANGUAGE AND COMPILER CONSTRUCTION
Formal definition of programming languages; specification of syntax and semantics. Global properties of algorithmic languages such as PL/1 and ALGOL. Review of special purpose languages for list processing, symbol manipulation, data description and simulation; run-time representation of program and data structures; how these properties affect compilation. Prereq: Math 612. 4 cr.
713. COMPUTER GRAPHICS
Input/output and representation of pictures from hardware and software points of view; emphasis on interactive techniques and the applications of these techniques; development of an interactive graphics system. Prereq: permission. 4 cr.

735. PROBABILITY
Sample spaces (discrete and continuous); random variables; conditional probability; moments; binomial, Poisson, and normal distributions; limit theorems for sums of random variables. Prereq: multidimensional calculus. 4 cr.

736. STATISTICS
Sampling theory, estimation of parameters, testing of hypotheses, nonparametric methods. Prereq: Math 735. 4 cr.

737. DECISION THEORY AND BAYESIAN METHODS
Utility, decision problems, prior and posterior distributions, sufficiency, estimation and hypothesis testing, linear models and sequential sampling. Emphasis on applications to business and economics. Prereq: Math 735. (Also offered as Econ 737.) 4 cr. (Not offered every year.)

738. MULTIVARIATE ANALYSIS
Multivariate distributions, convergence theorems, estimation and hypothesis testing, multivariate ANOVA, principal components, canonical correlations, discriminant analysis. Prereq: Math 735; either 645 or 762. 4 cr. (Not offered every year.)

753. NUMERICAL METHODS AND COMPUTERS I
Use of numerical analysis on computers; high-level languages, compilers; linear and nonlinear equations; interpolation, quadrature, curve fitting, system simulations, optimization techniques, finite elements, computer graphics. Selected algorithms will be programmed for computer solution. Prereq: calculus; intro. to comp. prog. 4 cr.

754. NUMERICAL METHODS AND COMPUTERS II
Computer solutions of ordinary and partial differential equations, finite differences vs. finite elements, eigenvalues an eigenvectors, algorithms for hidden-line graphics. Mathematical software. Prereq: differential equations; intro. to comp. prog. 4 cr.

761. ABSTRACT ALGEBRA
Basic properties of groups, rings, fields, and their homomorphisms. Prereq: introduction to abstract mathematics. 4 cr.

762. LINEAR ALGEBRA
Vector spaces, linear transformations, matrices, determinants, dual spaces, eigenvalues, spectral and canonical decomposition theorems. Not for credit if credit received for Math 645. Prereq: Math 761. 4 cr.

764. ADVANCED ALGEBRA
Vector spaces, modules over principal ideal domains, structure of finitely-generated modules, finite abelian groups, elementary theory of fields. Prereq: Math 761. 4 cr. (Not offered every year.)

767. ONE-DIMENSIONAL REAL ANALYSIS
Theory of limits, continuity, differentiability, integrability, series, uniform convergence. Prereq: multidimensional calculus; intro. to abstract math. 4 cr.

768. ABSTRACT ANALYSIS
Metric spaces, function spaces, theory of uniform limits. Prereq: Math 767. 4 cr. (Not offered every year.)

769. MULTIDIMENSIONAL REAL ANALYSIS
Partial derivatives, multiple integrals, line and surface integrals, Fourier series. Prereq: Math 767. 4 cr.

776. LOGIC
Formal mathematics and formal systems. Consistency, completeness, decidability. Prereq: introduction to abstract mathematics. 4 cr. (Not offered every year.)

784. TOPOLOGY
Connectedness, compactness, metrizability, with special emphasis on real line and plane. Prereq: introduction to abstract mathematics. 4 cr.

785. ALGEBRAIC METHODS IN TOPOLOGY
Topology of manifolds, topological groups, homology, knot theory. Prereq: Math 784. 4 cr. (Not offered every year.)

788. COMPLEX ANALYSIS
Complex functions, sequences, limits, differentiability and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Not for credit if credit received for Math 647. Prereq: Math 767. 4 cr.

The following courses may be applied to the degree of Master of Science for Teachers in mathematics and to no other graduate degree in mathematics.
801-802. MATHEMATICS AND COMPUTING FOR TEACHERS
Linear equations, linear inequalities, computer arithmetic and programming, never-ending algorithms, algorithms for areas, computer-oriented numerical methods. The course is designed to introduce methods of computation using a computer in the context of a mathematics course. BASIC and FORTRAN programming languages will be taught. 6 cr.

803-804. HIGHER ALGEBRA FOR TEACHERS
The integers, integral domains, and topics from number theory; equivalent relations and congruences; real numbers, complex numbers, and fields, polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

805-806. HIGHER GEOMETRY FOR TEACHERS
Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry; and topology. 3 cr.

807-808. HIGHER ANALYSIS FOR TEACHERS
The real number system; variables, functions and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral maxima and minima. 3 cr.

809. PROBABILITY AND STATISTICS FOR TEACHERS
Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 cr.

810. MATHEMATICS EDUCATION
Current developments and issues in mathematics education. A seminar focused on content, curricula, methods, and psychology of teaching mathematics. 1-4 cr.

811. COMPUTERS AND THEIR USES
3 cr.

814. TOPOLOGY FOR TEACHERS
Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 cr.

815. THEORY OF NUMBERS FOR TEACHERS
Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. 3 cr.

817. THEORY OF SETS AND ELEMENTARY LOGIC
An introduction. 3 cr.

819. THE REAL NUMBER SYSTEM
A postulational approach. Brief discussion of algebraic structures. Introduction to the sequences, limits, and continuity. 3 cr.

820. HISTORY OF MATHEMATICS
A problem-study approach to mathematical problems and solutions from the period of Greek mathematics until the 1950s will be used to present the history of mathematics. 3 cr.

821. A MODERN APPROACH TO GEOMETRY
The foundations and development of Euclidean geometry, with emphasis on the recent School Mathematics Study Group's recommendations in the field of high school geometry. 3 cr.

826. SELECTED TOPICS IN ALGEBRA
Topics selected to supplement the teacher's previous training in algebra, chosen from among the following: linear algebra, vector spaces, groups, rings and ideals, and fields. 3 cr.

827. SELECTED TOPICS IN GEOMETRY
Topics selected to supplement the teacher's previous training in geometry, chosen from among the following: analytic projective geometry, non-Euclidean geometry, transformation theory, elementary metric differential geometry, topology. 3 cr.

828. SELECTED TOPICS IN ANALYSIS
Topics selected to supplement the teacher's previous training in analysis, chosen from among the following: sequences and series of real functions, Riemann integration, partial differentiation, complex functions, differential equations. 3 cr.

829. DIRECTED READING
A directed reading project on a selected topic in mathematics chosen to supplement the teacher's previous institute courses. A written examination will be required. 3 cr.

The following are the basic courses for both the Master of Science and Doctor of Philosophy degrees in mathematics.

833-834. ALGEBRA
Groups; rings, modules; fields; linear algebra. Prereq: undergraduate abstract algebra. 3 cr.

835. MEASURE AND INTEGRATION
Outer measures and measures; Lebesque integrals; convergence theorems. Prereq: undergraduate real analysis. 3 cr.
836. FUNCTIONAL ANALYSIS
Banach spaces; representation of linear functionals; weak and weak* topologies. Prereq: Math 835. 3 cr.

837. COMPLEX ANALYSIS
Open mapping theorem; maximum modulus theorem; normal families and Riemann mapping theorem; harmonic functions; representation theorems; analytic continuation. Prereq: undergraduate complex analysis. 3 cr.

838. ALGEBRAIC TOPOLOGY
Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products. Prereq: undergraduate abstract algebra and topology. 3 cr.

839. GENERAL TOPOLOGY
Subspace, product and quotient topologies; embedding; separation and countability axioms; connectedness; compactness and compactifications; paracompactness, metrization and metric completions. Prereq: undergraduate general topology. 3 cr.

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

841. TOPICS IN LOGIC AND FOUNDATIONS
Recursive functions; independence proofs; models; forcing techniques. 3 cr.

842. TOPICS IN ALGEBRA
Homological algebra; algebraic number theory; local algebra; category theory; group theory; ring theory; field theory. 3 cr.

843. TOPICS IN TOPOLOGY
Topological groups; algebraic topology; general topology. 3 cr.

844. TOPICS IN ANALYSIS
Calculus of variations; harmonic analysis; integral equations; operator theory; linear topological spaces; partially ordered spaces; topological algebras; complex variables. 3 cr.

845. TOPICS IN DIFFERENTIAL EQUATIONS
Linear systems; general autonomous systems; two-dimensional systems; boundary value problems; qualitative theory; stability theory; partial differential equations; functional analytic methods. 3 cr.

846. TOPICS IN APPLIED MATHEMATICS
Distribution theory; potential theory; mechanics; control theory; mathematical biology; model theory; operations research. 3 cr.

847. TOPICS IN MATHEMATICS EDUCATION
The psychology of teaching and learning mathematics; supervision in mathematics teaching; curriculum theory; new curriculum projects; curriculum evaluation. 3 cr.

848. TOPICS IN GEOMETRY
Analysis on manifolds; differential geometry; Riemannian geometry; algebraic geometry; convexity. 3 cr.

849. TOPICS IN PROBABILITY AND STATISTICS
Time series analysis; analysis of variance; stochastic processes; probability; design of experiment; hypothesis testing; estimation theory; non-parametric statistics. 3 cr.

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

850. OPTIMIZATION METHODS AND COMPUTERS
Optimization methods applied to problems in engineering, science, and management. Classical optimization methods; dynamic programming; integer programming; separable programming; search methods; geometric programming; combinatorial optimization. Prereq: Math 753 or permission. 3 cr.

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

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

853. ARTIFICIAL INTELLIGENCE
Current approaches to machine intelligence and the simulation of human cognitive processes, including an introduction to recursive functions and programming with the LISP language. Heuristic programming, programs for game playing and natural language understanding, elementary theory of computability. Individual computer project required. Prereq: programming experience. 3 cr. (Also offered as E E 853.)
854. AUTOMATA THEORY
Formal languages and theoretical "machines" or automata. Formal grammars; context-dependent, context-free, and regular languages; finite state machines and regular expression recognizers; infinite state machines; Turing machines; unsolvable problems and the halting problem; linear-bounded and push-down automata; cellular and reproducing automata. Prereq: programming experience. 3 cr. (Also offered as E E 854.)

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

856. 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. Nets such as ARPA. Prereq: E E 712 or equivalent; Math 855. 3 cr.

The following courses are introductions to research opportunities for Doctor of Philosophy candidates. With the permission of the instructor, each of these courses may be taken more than once for credit.

861-862. ADVANCED TOPICS IN ALGEBRA 3 cr.
865-866. ADVANCED TOPICS IN GENERAL TOPOLOGY 3 cr.
867-868. ADVANCED TOPICS IN ALGEBRAIC GEOMETRY 3 cr.
869-870. ADVANCED TOPICS IN FUNCTIONAL ANALYSIS 3 cr.
871-872. ADVANCED TOPICS IN ALGEBRAIC TOPOLOGY 3 cr.
873-874. ADVANCED TOPICS IN APPLIED MATHEMATICS 3 cr.

879, 880. ADVANCED TOPICS IN MATHEMATICS EDUCATION 3 cr.

898. READING COURSES

899. THESIS/PROJECT IN COMPUTER SCIENCE 3-6 cr.

999. DOCTORAL RESEARCH

Mechanical Engineering (M E)

Chairperson: William Mosberg

PROFESSORS: Robert W. Corell, Godfrey H. Savage, Charles K. Taft, Asim Yildiz
ASSISTANT PROFESSOR: M. Robinson Swift

The mechanical engineering department offers programs of study, from the viewpoint both of the engineering sciences and of engineering design, in mechanics, materials science, automatic control, and the thermal sciences, leading to the degree of Master of Science in Mechanical Engineering. The programs provide the background required for careers in research, engineering design, or teaching, or for further graduate study.

To be admitted to graduate study in mechanical engineering, students should have completed work equivalent to that required by the University of New Hampshire for a Bachelor of Science degree in the field.

A candidate for the degree of Master of Science shall satisfy the requirements of either a thesis plan or a project plan. The thesis plan requires 24 semester hours of coursework in addition to Mechanical Engineering 899, Master's Thesis; the project plan requires 30 semester hours of coursework in addition to Mechanical Engineering 892, Master's Project. Individuals with special qualifications may petition the department to be excused from the project requirement. An oral examination covering the candidate's graduate work will be given whether or not a thesis is presented.

Students interested in graduate study beyond the master's degree should refer to the interdepartmental Engineering Ph.D. program which
includes the following areas of specialization: engineering system
design, signal processing, theoretical and applied mechanics, and
transport phenomena. For details refer to the section entitled Engineering Ph.D. Program on page 82.

No more than two graduate courses taken prior to admission to the
Graduate School may be applied to the master's degree. Courses
numbered between 600 and 699 may be taken for graduate credit by
non-majors only.

Permission of the instructor and consent of the adviser are required
for enrollment in all mechanical engineering graduate courses.

701. MACROSCOPIC THERMODYNAMICS
Thermodynamic principles using an analytic, postulational
approach and Legendre transformations to obtain thermodynamic
potentials. Prereq: Thermodynamics I. 4 cr.

702. STATISTICAL THERMODYNAMICS
Macroscopic thermodynamic principles developed by means of
microscopic analysis. Prereq: Thermodynamics I. 4 cr.

703. HEAT TRANSFER
Analysis of phenomena; steady-state and transient conduction,
radiation, and convection; engineering applications. Prereq: ther-
modynamics; fluid dynamics. 3 cr.

704. EXPERIMENTAL HEAT TRANSFER
Methods in the study and solution of problems, including a critical
comparison with analytical and other methods. Prereq: M E 703.
4 cr.

707. ANALYTICAL FLUID DYNAMICS
Potential flow, development of the Navier-Stokes equations, tur-
bulence and boundary-layer theory. Prereq: thermodynamics; fluid
dynamics. 4 cr.

708. GAS DYNAMICS
Basic equations of motion of one-dimensional, subsonic and super-
sonic flows of compressible, ideal fluids. Wave phenomena.
Rankine-Hugonoit relations. Linear approach to two-dimensional
flow problems. Prereq: thermodynamics; fluid dynamics. 4 cr.

710. SOLAR HEATING SYSTEMS
Analysis and computer modeling of solar radiation as an energy
source for heating. Phenomena, availability, collection, perform-
ance, and economy of solar energy for heating systems. Prereq:
M E 703. 3 cr.

715. INTERNAL COMBUSTION ENGINES
Basic and engineering science applied to spark and compression-
ignition engines; design, management, and reporting of experimen-
tal studies. Prereq: thermodynamics. 4 cr.

716. PROPULSION SYSTEMS
Basic engineering sciences applied to the engineering problems of
propulsion systems. Prereq: thermodynamics; fluid dynamics. 4 cr.

717. CRYOGENICS
Phenomena and processes with 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. Prere-
req: thermodynamics I. 4 cr.

723. ADVANCED DYNAMICS
Classical dynamics oriented to contemporary engineering applica-
tions. Review of particle dynamics. Hamilton's principle and the
Lagrange equations. Kinematics and dynamics of rigid bodies,
gyrosopic effects in machinery and space structures. Prereq:
mechanics. 4 cr.

724. VIBRATION THEORY AND APPLICATION
Theory of discrete vibrating systems. Single-degree-of-freedom
system with general excitation. Matrix theory and eigenvalue pro-
systems. Applications to structural and mechanical systems. Prere-
req: introduction to vibrations or graduate standing. 4 cr.

726. EXPERIMENTAL MECHANICS
Experimental methods and theoretical bases applied to measure-
ment of stress, strain, and motion. Transmitted and scattered-light
photoelasticity; strain gage applications; brittle coating and grid
techniques; dynamic measurements, and associated instrumenta-
tion. 4 cr.

727. ADVANCED MECHANICS OF SOLIDS
Beams on elastic foundation, curved bars, inelastic behavior, in-
stability, introduction to thin plates and shells, introduction to
elasticity, energy methods, and numerical methods. 4 cr.

730. 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 continuum mechanics on the macroscopic scale. Elasticity, plasticity, viscoelasticity, creep, fracture, and damping. Anisotropic and heterogeneous materials. 4 cr.

737. OCEAN MECHANICS I
Ocean as a continuous medium, its mechanical and thermodynamic properties. Shallow and deep ocean modeling for the investigation of gravity and sound waves. Ocean subbottom and its soil mechanical and sound propagation properties. Instrumentation, rudimentary data collecting and processing procedures, and computer usage. Prereq: fluid dynamics and mechanics; differential equations; multidimensional calculus. 4 cr.

738. OCEAN MECHANICS II
Ocean dynamical laws are generalized to include temperature and salinity variations in the water column. Conservation laws with generalized equation of state. Air-sea interaction, energy transport phenomena, reflection from different coastal geometry, harbour resonances, internal currents. Sound reflection from subbottom sound probing techniques to determine subbottom properties by ray theory, and generalization of subbottom soil from an elastic to a viscoelastic medium. Prereq: M E 737; M E 781 is desirable but not required. 4 cr.

741. FLUID CONTROL SYSTEMS
The mathematical modeling of hydraulic, pneumatic, and fluidic-control elements and control systems. Methods are developed for the analysis of systems using gases or liquids as the working fluid. Methods for the synthesis of the parameters of the control elements, used in automatic control systems, are developed and methods of design of these systems are discussed. (Also offered as E E 741.) 4 cr.

751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING
Fundamentals of naval architecture in ocean environments applied to conventional and advanced surface, semisubmersible, and submersible vehicles. Geometric considerations, hydrostatic characteristics, and basics of powering and principal rules are covered. Prereq: fluid mechanics; mechanics/or permission. 4 cr.

752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN
Conceptual and preliminary design of submersible vehicle systems: submersibles, environmental factors, hydromechanic and structural principles, materials, intra/extravehicle systems, operating considerations, predesign and design procedures. Design projects are selected and completed by student teams. Prereq: permission. 4 cr.

757. COASTAL ENGINEERING AND PROCESSES
Water waves and their effects. Equations for gravity waves and laboratory tank demonstration of wave trains, wave groups, and wave spectra. Estuarial and coastal processes including wave refraction and long shore transport of sediments simulated by computer models. Effects of structures on waves and functional design of structures including towers, breakwaters, and ocean outfall. 4 cr.

760. PHYSICAL METALLURGY
Introduction to the electron theory of materials: entropy and free-energy concepts of the solid state; diffusion in metals; nature and kinetics of selected solid state reactions. 4 cr.

761. X-RAY DIFFRACTION
The physics of x-ray diffraction, the reciprocal lattice, lattice parameter determinations, space group identification, phase identification, characterization of preferred orientation. 4 cr.

763. MICROSTRUCTURE OF SOLIDS
Basic concepts and measurements; statistically exact expressions for points, lines, surfaces, and volumes; random, partially-oriented and oriented structures; particle and grain characteristics and distributions, projected images and shape specification. 4 cr.

766. PHYSICAL CERAMICS
Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation, crystal growth, and solid-state reactions; kinetics of grain growth, sintering, and vitrification. 4 cr.

771. DYNAMIC SYSTEMS MODELING
Lumped parameter models for mechanical, electrical, fluid, thermal, and mixed systems. Time-domain solutions, frequency-response plots, matrix representations, eigen vectors, and eigenvalues are used to explore system response. Introduction to nonlinear analysis, simulation, computer applications. 3 cr.

781. 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.
Mechanical Engineering

782. CONTROL SYSTEMS
Fundamental principles involved in the design and analysis of feedback control systems. Topics include stability criterion, time-domain analysis, frequency-domain analysis, and introduction to nonlinear systems. (Also offered as E E 782.) 4 cr.

793 A-D, 794 A-D. SPECIAL TOPICS IN ENGINEERING
Course numbers refer to topics in A) thermodynamics; B) mechanics; C) engineering design; and D) materials, respectively. Content of these courses may vary from year to year. 2-4 cr.

795 A-D, 796 A-D. INDEPENDENT STUDY
Course numbers refer to topics in A) thermal science; B) solid mechanics; C) engineering design; and D) materials, respectively. 2-4 cr.

801. IRREVERSIBLE THERMODYNAMICS
Nonequilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prereq: M E 701. 4 cr.

803. 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.

804. RADIATION HEAT TRANSFER
The fundamentals of radiant heat transfer. Development and solution of the wave equation for electromagnetic radiation. Analysis of Planck's law of radiation and earlier theories. Methods of solution of radiant interchange in real systems with and without absorbing media. 4 cr.

806. CONVECTION HEAT TRANSFER
An analytical study of heat transfer to laminar and turbulent boundary layers of compressible and incompressible fluids. Basic differential equations governing the heat transfer are derived and analytical solutions are obtained where possible and checked with experimental results. 4 cr.

807. COMPRESSIBLE FLUID FLOW
General equations of motion for real and ideal compressible fluid flow, including boundary layer equations, methods of solution. Prereq: M E 707 or 708. 4 cr.

808. THEORETICAL AERO/HYDRO-MECHANICS
The mathematical development of the equations of frictionless fluid flow, using both tensor notation and various coordinate systems. Conformal mapping; Blasius theorem; Joukowski hypothesis; flow around airfoils. Schwarz Christoffel theorem and vortex motion. 4 cr.

822. CONTINUUM MECHANICS
Conservation laws for gases, liquids, and solids in a continuum are developed starting from Liouville and Boltzmann equations. Passage from a discrete system to a continuum is discussed. Constitutive equations for viscoelastic and thermoelastic fields; and nonlinear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases, and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

824. VIBRATIONS OF CONTINUOUS MEDIA
Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

826. THEORY OF ELASTICITY
The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogenous, anistropic, wave equations; wave propagation, and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 cr.

827. THEORY OF PLASTICITY
Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

829. THEORY OF PLATES AND SHELLS
Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.
838. **THEORETICAL ACOUSTICS**
Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include: a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

842. **DISCONTINUOUS CONTROL**
Analysis and synthesis of feedback control systems operating on quantized information; compensation and performance improvement methods which use the quantized nature of the information are also developed. 4 cr. (Also offered as E 842.)

844. **NONLINEAR CONTROL SYSTEMS**
Analysis and design of nonlinear control systems from the classical and modern viewpoints are discussed. Topics include: 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: M E 851. 4 cr. (Also offered as E E 844.)

851. **ADVANCED CONTROL SYSTEMS I**
State-space representation of systems. Analysis using state transition matrix. Controllability and observability. Synthesis of optimum control systems, including calculus of variations and maximum principle. Introduction to nonlinear and stochastic data systems including stability concepts using Liapunov and Popov criteria. Sampled data systems. Prereq: M E 782. 3 cr. (Also offered as E E 851.)

852. **ADVANCED CONTROL SYSTEMS II**
Special topics in control theory such as multivariate and adaptive control system; stochastic systems; Wiener and Kalman filter techniques; introduction to dynamic, linear, and non-linear programming. Prereq: M E 851. 3 cr. (Also offered as E E 852.)

865. **CONDUCTION PROPERTIES IN SOLIDS**
Topics in metal and semiconductor physics. Quantum theory, electron energy states, scattering processes, band theory, electron and hole conduction, and the P-N junction. 4 cr.

882. **MATHEMATICAL METHODS IN ENGINEERING SCIENCE II**
This course is a continuation of M E 781. Topics treated include 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: M E 781. 4 cr.

883. **TENSOR ANALYSIS AND DIFFERENTIAL GEOMETRY**

890 A-D. **891 A-D. SPECIAL TOPICS IN ENGINEERING**
C) coursework numbers refer to topics in A) thermodynamics; B) mechanics; C) engineering design; and D) materials. Content of these courses may vary from year to year. 2-4 cr.

892. **MECHANICAL ENGINEERING MASTER'S PROJECT**
The student works with a faculty member during one or two semesters on a well-defined research and/or original design problem. A written report and seminar are presented. 1-4 cr.

895 A-D. **896 A-D. GRADUATE INDEPENDENT STUDY**
Investigation of graduate-level problems or areas germane to mechanical engineering. 1-4 cr.

899. **MASTER'S THESIS**
6-10 cr.

**Students may also enroll in Technology 601.**

601. **STATISTICAL METHODS IN ENGINEERING AND PHYSICAL SCIENCE**
Methods of organizing data and statistical techniques for data analysis, as applied to problems in engineering and physical science. Elementary probability theory, probability distribution; tests of significance, correlation, and regression analysis. Design of experiments; completely randomized blocks; factorials, fractional factorials; process optimization. Introduction to quality control; construction and analysis of control charts for variables and attributes; statistical aspects of tolerance. 4 cr.
Microbiology

Microbiology (Micr)

Chairperson: Galen E. Jones

PROFESSORS: William R. Chesbro, Galen E. Jones, Theodore G. Metcalf
ASSOCIATE PROFESSORS: Thomas G. Pistole, Robert M. Zsigray
ASSISTANT PROFESSORS: David L. Balkwill, Richard P. Blakemore

Students admitted to graduate study in microbiology are expected to have had adequate preparation in the biological and physical sciences and in the basic courses in microbiology.

The candidate for the Master of Science degree will be required to complete a thesis. Candidates for the Doctor of Philosophy degree must teach at least one semester, or have had equivalent experience; must demonstrate to the doctoral committee a broad, basic knowledge of the field of microbiology; and must complete a dissertation embodying the results of original research in microbiology.

Departmental research activities emphasize bacterial host-parasite interactions, immunology, analysis of microbial structures, bacterial and bacteriophage genetics, environmental virology, cell culture phenomena, public health aspects of microbiology and virology, bacterial physiology, and marine and soil microbiology.

701. TAXONOMY AND ECOLOGY
Isolation, identification, and classification of procaryotes by classical and newer techniques; analysis of the interplay between organism and environment based on energy metabolism and use of this to deduce a natural classification; uses of taxonomic and ecological information. Lab. Prereq: gen micro; gen biochem or Physiological Chem and Nutrition or Principles of Biochem. 4 cr.

702. PATHOGENIC MICROBIOLOGY
The morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Lab. Prereq: Gen Micr. 4 cr.

705. IMMUNOLOGY AND SEROLOGY
Defensive elements possessed by man and animals protective against infectious microorganisms. Principles of serological techniques for recognition and identification of biological materials including microorganisms. Preparation of vaccines and production of antiserum in animals. Lab. Prereq: Path Micr. 4 cr.

706. Virology
Viruses, including animal and bacterial, and rickettsiae; interaction of viruses and host cells; techniques for propagation and recognition including immunologic methods; applications to infectious disease, the environment, and cancer. Lab. Prereq: Path Micr. 4 cr.

707. Marine Microbiology
Characterization of microorganisms in the sea including taxonomy, physiology, and ecology; sampling, enumeration, distribution; and effects of marine environment upon microbial populations. Lab. Prereq: Gen Micr; Org Chem. 4 cr.

708. Microbial Biogeochemistry
Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferromanganese nodules, corrosion and fossil microorganisms. Lab. Prereq: Gen Micr; Org Chem. 4 cr.

709. Microbial Cytology and Ultrastructure

710. Microbial Cytology Laboratory
Light and electron microscopic techniques for the study of microbial cytology: theory and use of the electron microscope, sample preparation methods, photomicrography and photographic darkroom techniques, interpretation of electron micrographs. Prereq: Gen Micr; 709 or concurrent registration; permission. Lab. 2 cr.

712. Soil Microbiology
Microbial ecology of the soil environment; characteristics of major microbial groups in soil; factors affecting activity of soil microorganisms; their effects on the environment; and biological interactions which involve them. Prereq: Gen Micr. Lab. 4 cr.

795, 796. Problems in Microbiology
Prereq: permission of department chairperson and staff. Cr. to be arranged.

800. Systematic Microbiology
Procedures, methods for classification of microorganisms; review of systems of classification. Lab. Prereq: one year of microbiology. (Not offered every year.) 4 cr.
802. MICROBIAL PHYSIOLOGY
Means by which microorganisms survive: nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Lab. Prereq: Gen Micr; gen biochem. (Not offered every year.) 4 cr.

804. MICROBIAL GENETICS
Expression, regulation, recombination of transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Lab. Prereq: Gen Micr; permission. (Not offered every year.) 4 cr.

806. ADVANCED IMMUNOLOGY
Basic concepts in immunology including immuno-recognition, effector systems, immunogenetics, immunopathology, and comparative immunology. Lab. Prereq: gen. immunol.; gen biochem; permission. 4 cr. (Not offered every year.)

808. ADVANCED MICROBIAL CYTOLOGY
Examination and discussion of selected topics; independent research using electron microscopy and/or other cytological methods. Lab. Prereq: gen. micr., electron microscopy; permission. 4 cr.

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

897-898. MICROBIOLOGY SEMINAR
Reports, discussions, microbiological literature, and current developments in microbiology. Prereq: permission of instructor. 1 cr.

899. MASTER'S THESIS
6-10 cr.

999. DOCTORAL RESEARCH

Music (Musì)

Chairperson: Paul Verrette

PROFESSORS: Donald Steele, John Wicks
ASSOCIATE PROFESSORS: Mark DeVoto, Alan Grishman, Cleveland Howard, Keith Polk, Mary Rasmussen, John Rogers, Niel Sir, Paul Verrette, John Whitlock, Henry Wing, Jr.

ASSISTANT PROFESSOR: Stanley Hetlinger

The Department of Music offers programs leading to the degrees of Master of Arts in music and Master of Science in music education.

Master of Arts in Music

The degree of Master of Arts in Music, while designed basically for students interested in broadening their knowledge of the history of music in all of its dimensions, has proven consistently valuable to students who wish to augment strong backgrounds in performance and/or education with more specialized studies in theory, literature, and performance-practice. The following courses (or their approved equivalents) are required: Music 855, 856, 857, 858, 891, and 893 or 894. Courses at the 700 level in music, or the 600, 700, and 800 level in other departments, may be elected with the approval of the student's adviser. It is recommended that more than two semesters be allowed for completion of the degree. The cultural advantages of the city of Boston, 90 minutes away, are a valuable adjunct to the program.

A B.A. degree in music or its equivalent from an accredited institution is required for admission to this program. A performance audition and a placement examination in theory, music history, and aural identification, are normally required of all applicants and are taken in the semester or summer preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the satisfaction of the department. A reading knowledge of both German and French is strongly recommended before entering the program; a German reading examination will be administered by the department. On recommendation of the graduate adviser, this requirement may be waived for students who do not plan further study beyond the M.A. degree. Completion of the program requires an oral exam and a written essay of substantive nature on a topic of the candidate's special interest.

Master of Science in Music Education

The goal of the Master of Science in music education degree is to develop a broad knowledge at the graduate level in the fields of music education, performance, history, theory, and independent study. Each
candidate will be required to complete one of the following: a professional paper; a field study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; or the preparation and conducting of a major work in public performance for band, orchestra, or chorus. The following courses are required: Musi 855, 893 or 894; MuEd 796; 883 or 884. Also required are two courses in the Department of Education from courses such as the following: Educ 820, 827, 841, 853, 858, 861, 865, 883, 884, 886, and in special cases, 700, 701, and 705. Vocal or instrumental study at the 800 level is required to a minimum of 4 credits. A maximum of 9 credits is allowed if the graduate recital option is elected. Sufficient electives must be taken to total 30 credits.

Admission to this program depends upon a bachelor's degree in music education or its equivalent from an accredited institution. Placement examinations in theory, music history, and aural identification will be required of all applicants. The student must take these examinations in the semester or summer preceding entrance into the graduate program. Students not meeting standards in the placement examinations will not be officially admitted to the Graduate School until such examinations are passed to the satisfaction of the department.

Music (Musi)

701. MUSIC OF THE MEDIEVAL PERIOD
The 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. 4 cr.

703. MUSIC OF THE RENAISSANCE
Works of 15th and 16th century composers from Dunstable to Palestrina. 4 cr.

705. MUSIC OF THE BAROQUE
Music of Europe from deRore to Bach. 4 cr.

707. MUSIC OF THE CLASSICAL PERIOD
The growth of musical styles and forms from early classical, baroque-influenced composers through the high classicism of Haydn and Mozart, to the budding romanticism of the young Beethoven. Representative symphonies, concerti, and operas will be heard. 4 cr.

709. MUSIC OF THE ROMANTIC PERIOD
The symphonies, concerti, chamber music, and keyboard works of Beethoven, Berlioz, Schubert, Mendelssohn, Schumann, Brahms, Franck, Chopin, and Liszt. Romantic elements contained in the development of harmony, orchestration, sonority, expressive content. The rise of the short piano piece, the German art song, the symphonic poem, nationalism in music. 4 cr.

711. MUSIC OF THE 20th CENTURY
Contemporary music including its literature, its trends, and an analysis of techniques, styles, forms, and expression. 4 cr.

721. THE LIFE AND WORKS OF BEETHOVEN
The piano sonatas, the concerti, symphonies, and string quartets. 4 cr.

732. THE ART SONG
The history and literature of the solo song with piano accompaniment. Survey of national styles of the 19th and 20th centuries and deeper study of the central core of the art song—the German Lied. 4 cr.

733. SURVEY OF OPERA
Representative masterpieces of this art form through reading, listening, and discussion. 4 cr.

735. SURVEY OF PIANOFORTE LITERATURE
Keyboard literature from Bach to the present. Discussion and performance of the works of Bach; the sonatas and concerti of Haydn, Mozart, Beethoven, Schubert, the romantic composers, and of contemporary writers. 4 cr.

751-752. Conducting Methods
Physical aspects, equipment of conductor, fundamental gestures and beats, baton techniques. Reading and analysis of full and condensed scores, study of transposition, psychology of rehearsal. Prereq: Theory II and junior standing. 2 cr.

754. COLLEGIUM MUSICUM
Instrumentalists and singers perform small ensemble music from all periods, with emphasis on Renaissance and Baroque music. Prereq: permission. 1 cr.

771-772. COUNTERPOINT
Contrapuntal techniques of tonal music. Melodic construction and dissonance treatment through work in species counterpoint and studies in harmonic elaboration and prolongation. Analysis of selected compositions emphasizes the connection between fundamental contrapuntal techniques and the voice-leading of composition. Prereq: Theory II or permission. 2 cr.
773. ADVANCED COUNTERPOINT
A continuation of Musi 772. Prereq: Music 772 or permission. 2 cr.

775-776. COMPOSITION
Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prereq: Musi 572 or permission of instructor. 3 cr.

777-778. ADVANCED COMPOSITION
A continuation of Musi 776. Individual compositional projects. Prereq: permission. 3 cr. (May be repeated for credit.)

779. ORCHESTRATION
The 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: Theory II or permission. 4 cr.

781. FORM AND ANALYSIS
Formal and textural elements; concepts and examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Prereq: Theory II or permission. 4 cr.

785. ELECTRONIC SOUND SYNTHESIS
Part I: “traditional” or “analog” electronic sound synthesis; work with the Buchla Synthesizer in the electronic music studio. Part II: 1) elementary programming in FORTRAN, 2) the logic of computer sound synthesis, and 3) programming in MUSIC 4BF. Students will have the opportunity to run programs on a DEC K10 computer equipped with 4-channel digital-to-analog and analog-to-digital converters. Part III: completion of a major independent study project in electronic music. Prereq: permission. 4 cr.

795. SPECIAL STUDIES IN MUSIC

841-850. 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. 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. Music staff. 1-2 cr.

841. GRADUATE VOICE
842. GRADUATE PIANO
843. GRADUATE HARP
844. GRADUATE ORGAN
845. GRADUATE VIOLIN, VIOLA
846. GRADUATE VIOLONCELLO, STRING BASS
847. GRADUATE WOODWIND
848. GRADUATE BRASS
849. GRADUATE PERCUSSION
850. GRADUATE HARP

855. INTRODUCTION TO BIBLIOGRAPHY
An intensive survey of basic reference works, music periodicals, collected editions, series, treatises, books on musical instruments and performance practice, and the important monographs on major composers from Machaut to Schoenberg. A reading knowledge of German and French is very useful. 3 cr.

856. READINGS IN MUSIC HISTORY: ANTIQUITY TO 1600
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

857. READINGS IN MUSIC HISTORY 1600-1820
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

858. READINGS IN MUSIC HISTORY: 1820 TO THE PRESENT
An opportunity to read and study in detail a restricted number of monographs and editions. 3 cr.

891-892. RESEARCH SEMINAR
Guidance in individual research projects. Prereq: permission. Variable cr.
THEORY SEMINAR
Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to Monteverdi. Prereq: permission. 3 cr.

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.

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.

Music Education (MuEd)

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.

MATERIALS AND METHODS IN PIANO MUSIC
Gives potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent through evaluation of methods and materials and discussion of the role of the private teacher. 2 cr.

TECHNIQUES AND METHODS IN STRING INSTRUMENTS
Class and individual instruction. Four hours 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.

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.

TECHNIQUES AND METHODS IN BRASS INSTRUMENTS
A 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. Qualified advanced students may elect honors work in composition, arranging, and ensemble coaching. 4 cr.

TECHNIQUES AND METHODS IN PERCUSSION INSTRUMENTS
Basic performance skills on snare drum, timpani, mallet instruments, and the other percussion instruments used in bands and orchestras. Materials and methods of instruction. 2 cr.

MUSIC FOR THE ELEMENTARY CLASSROOM TEACHER
Designed for the non-specialist. The correlation and integration of music in the school curriculum, and the basic skills and techniques necessary. 4 cr.

THE TEACHING OF ELEMENTARY AND MIDDLE SCHOOL MUSIC
Aims, scope, and organization of materials and activities in the elementary and middle schools. Modern trends in educational philosophy; development of the child's voice; demonstration of materials and methods for the various grades. Observation and teaching in schools. 2 cr.

THE TEACHING OF SECONDARY SCHOOL MUSIC
Educational principles applied to music teaching and learning; curriculum organization for junior and senior high school. Adolescent voice, voice classification, selection of vocal and instrumental materials, and building unified concert programs. Problems of administration; management; relationship of the teacher to school and community. Observation of secondary school music programs. 2 cr.

SPECIAL STUDIES IN MUSIC EDUCATION
Allows upper-level students to explore, individually or in groups, areas related to their specific professional interests. Prereq: permission. 1-4 cr.

ORGANIZATION AND ADMINISTRATION OF SCHOOL MUSIC GROUPS
Problems of organizing and administering school orchestras, bands, glee clubs, choruses, and small ensembles; objectives, motivation, schedule, discipline, equipment, programs, finances, rehearsal techniques, contests and festivals, materials, personnel selection, and grades. 4 cr.
883. **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.

884. **CHORAL LITERATURE AND ITS PERFORMANCE**
Analysis, discussion, and conducting of excerpts from choral masterpieces from all major periods and styles. Students will have the opportunity to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college repertoires. 3 cr.

885. **SPECIAL PROJECTS IN MUSIC EDUCATION**
Independent study, investigation, or research in music education. Creative projects may be included. Prereq: permission. 1-4 cr.

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**Occupational Education (OcEd)**

**Chairperson:** William H. Annis

**PROFESSORS:** William H. Annis, Maynard C. Heckel
**ASSOCIATE PROFESSORS:** Richard L. Barker, Nicholas L. Paul, Lewis Roberts, Jr.
**ASSISTANT PROFESSOR:** Gregory D. Gill

The Master of Occupational Education degree is designed for teachers and administrators of occupational education, county Cooperative Extension Service personnel, and others in adult education. Applicants must submit scores achieved on either the Graduate Record Examination, Aptitude Section, or the Miller Analogies Test. All students are required to complete Occupational Education 785 and 786. The remainder of the 30+ credits required to complete the degree program will be selected in consultation with the student and advisers according to the student's career plans, needs, and goals. Students may elect the thesis plan. Candidates completing a thesis will be required to complete an oral examination. Students following the nonthesis plan will be required to complete both written and oral examinations. For further information contact Chairperson William H. Annis.

700. **WORKSHOPS IN OCCUPATIONAL EDUCATION**
Modularized instruction for inservice education of teachers of vocational education and others in occupational education. May be repeated up to 8 credits. 1-2 cr.

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883. **SHOP ORGANIZATION AND CONTROL METHODS**
Efficiency in the control of instruction, equipment, and materials. 4 cr.

883. **PREPARATION FOR CONDUCTING AND SUPERVISING ADULT-EDUCATION PROGRAMS**
Techniques of needs identification, program planning; teaching methods; supervision, and evaluation. Prereq: Princ of Occupational Ed or permission. 4 cr.

884. **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.

885. **ADVANCED METHODS AND MATERIALS OF INSTRUCTION**
Organization of instruction to meet student needs; development and use of resource files and instructional materials; evaluation. Open to teachers of vocational-technical education and others by permission. 4 cr.

886. **CONCEPTS OF OCCUPATIONAL EDUCATION**
Development of vocational-technical education in the U.S.; socio-economic influences responsible for its establishment. Federal and state requirements for secondary and postsecondary schools. Coordination of programs with general education and other vocational fields. 4 cr.

887. **ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION**
Special competencies required and operating philosophies examined for supervision and administration in the several areas of vocational education. 4 cr.

791. **PLANNING FOR TEACHING**
Organization of materials of instruction to meet group and individual needs. Techniques of instruction, planning for teaching, function of consulting committees, working with youth groups, program evaluation. Course scheduled concurrently with student teaching. Prereq: Micro Teaching. 4 cr.

796. **INVESTIGATIONS IN OCCUPATIONAL EDUCATION**
A) Career Education; B) Secondary Education; C) Postsecondary Education; D) Adult Education; E) Extension Education; F) Exemplary Programs; G) Cooperative Education Programs; H) Disadvantaged and Handicapped Education programs. Student-selected problems in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. May be repeated. 2 to 4 cr.
Physical Education

798. OCCUPATIONAL EDUCATION SEMINAR
Discussion of current issues, problems, and research and development in occupational education. Students, faculty, and other personnel are utilized as discussion leaders. Required of majors and minors. 0 cr.

802. METHODS OF TEACHING POWER AND MACHINERY IN OCCUPATIONAL EDUCATION
The servicing and maintenance of the agricultural power and machine complex as it relates to the production and nonproduction phases of vocational agriculture. The development of teaching plans, techniques of instruction, and the development of multimedia teaching units. 3 cr.

804. PROGRAM PLANNING IN OCCUPATIONAL EDUCATION
A systematic approach to the development of course materials for occupational education. Topics included are: occupational analysis, establishing performance objectives, selection of content, development of supplemental material, and evaluation. Prereq: a course in teaching methods or permission. 4 cr.

805. THE DEVELOPMENT OF COOPERATIVE EDUCATION PROGRAMS IN OCCUPATIONAL EDUCATION
Topics included are: relationship with community; student selection and development of individual programs; the supervision and evaluation of these programs. 4 cr.

807. ORGANIZATION AND SUPERVISION OF YOUTH ORGANIZATIONS
The purposes and organization of youth organizations, establishing the local organization, planning and developing a program of work, ways and means of improving the local organization, and methods of evaluation. 4 cr.

809. COMMUNITY ORGANIZATION AND PUBLIC RELATIONS
The composition, purposes, and objectives of the various social and economic organizations operating in local communities. The importance of their membership to the general welfare of the area and the development of a public relations program. 4 cr.

811. INTERNSHIP IN OCCUPATIONAL EDUCATION
Internship in a field of occupational 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. 0-8 cr. May be repeated up to 8 cr.

812. INTRODUCTION TO RESEARCH
The course is designed to develop a knowledge and understanding that will contribute to the effective use of research in teaching and administering occupational education. The research process will be examined in terms of selection and formulation of research problems, design, techniques of data collection, analysis, and interrelation of data and reporting. 4 cr.

895. INDEPENDENT STUDY IN OCCUPATIONAL EDUCATION
Individual study problems in various phases of occupational education. Prereq: permission. May be repeated. 2-6 cr.

899. MASTER OF OCCUPATIONAL EDUCATION THESIS
6-10 cr.

Physical Education (PhEd)

Chairperson: Phyllis A. Hoff

ASSISTANT PROFESSOR: D. Michael McKeough
DIRECTOR OF GRADUATE PROGRAM: Walter E. Weiland

The Department of Physical Education, in the School of Health Studies, offers a graduate program leading to the degree of Master of Science. Admission evaluation is based on undergraduate preparation, academic record, Graduate Record Examination scores (students must submit GRE scores for the aptitude test), and letters of recommendation. Applicants must be above-average students and have had a minimum of 24 credits of undergraduate theory work in physical education. Applicants who have not majored in physical education as undergraduates, or who have not met specific course prerequisites, should expect to take additional undergraduate work without receiving graduate credit.

Students may satisfy program requirements for the master's degree through either thesis or nonthesis program plans. Physical Education 801 and Natural and Environmental Resources 701, or a comparable statistics course (upon approval of graduate adviser) are required of all degree candidates.

Thesis Plan: A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) are required in the thesis plan. Two courses, in addition to Natural and Environmental Resources 701, must be taken outside the Department of Physical Education. An oral defense of the thesis is also required.
Nonthesis Plan: A minimum of 32 approved graduate credits are required in the nonthesis plan. Four credits of either Physical Education 895 or 896 (Advanced Studies) are required. Students may take Advanced Studies courses only after having completed at least 20 approved graduate credits, including Physical Education 801 and Natural and Environmental Resources 701. All coursework may be taken within the Department of Physical Education; however, approval may be granted to take relevant courses outside the department.

The program emphasizes the areas of 1) exercise physiology and 2) motor learning. In addition to these two areas of program emphasis, courses are offered in curriculum planning and in the historical, cultural, and social foundations of human movement and sport. Thesis topics need not be restricted to the two areas of program emphasis. The program is sufficiently flexible to satisfy professional interests and special abilities of the student. With the help of the graduate adviser, the student's program will be individually planned.

702. ADVANCED ATHLETIC TRAINING
Assessment, rehabilitative treatment, preventive strapping, and protective equipment used in athletic training. Administration of training room facility. Lab. Prereq: PhEd 502. 4 cr.

703. LABORATORY PRACTICE IN ATHLETIC TRAINING
150 hours of experience in UNH athletic training room under N.A.T.A. certified trainer. Prereq: PhEd 502. 600 clock hours necessary for N.A.T.A. certification. May be repeated up to 8 credits. 2 cr.

720. INTERPRETATION AND ASSESSMENT OF PHYSICAL FITNESS
Planning and implementation of programs of conditioning and fitness in the general program of education in the school. Personal fitness; components of physical fitness and conditioning: current tests; rehabilitation of individuals of all ages, particularly in college and adult programs. Prereq: PhEd 620 or equivalent. 4 cr.

730. CURRICULUM PLANNING IN PHYSICAL EDUCATION
Criteria and factors involved in planning and construction of school programs. 4 cr.

740. PERCEPTUAL MOTOR DYSFUNCTION
Theoretical rationale and clinical perceptual-motor training programs of Ayres, Kephart, Cratty, Barsch, and Getman, as they relate to sensory-motor integration and the remediation of learning disabilities. Prereq: PhEd 775, Motor Development of the Young Child, or permission. 4 cr.

775. PERCEPTUAL MOTOR LEARNING
Variables affecting the learning and performance of skilled activity; ability and motivational characteristics of the learner; processes for skill acquisition. Prereq: Psyc 401. 4 cr.

780. PSYCHOLOGICAL FACTORS IN SPORT
Factors of outstanding athletic achievement; psychological variables in competition; the actions and interactions of sport spectator, and athlete. Prereq: Intro to Psych. or PhEd 775. 4 cr.

791. HISTORY OF PHYSICAL EDUCATION
From ancient Egypt to modern times. Influences of Greece, Rome, the Renaissance and Reformation periods, and modern European nationalism. Analysis of events and the beliefs of leaders in the development of systems of physical education. 4 cr.

795. SPECIAL TOPICS
New or specialized courses not normally covered in regular course offerings. Prereq: permission. May be repeated up to 8 cr. 2-4 cr.

801. RESEARCH METHODS IN PHYSICAL EDUCATION
Research techniques and methodology, hypothesis formulation, format of research report, and critical reading of current research. Prereq: INER 701 or equivalent. 4 cr.

831. CONDITIONING FOR MAXIMUM PERFORMANCE
Anatomical and physiological factors related to maximum physical performance. Evaluation of present programs of training. Prereq: PhEd 620 or equivalent. 4 cr.

841. SOCIAL DIMENSIONS OF SPORT
Sport viewed from a social-cultural, action-system frame of reference and studied on the level of cultural values and their related social structures. Prereq: Soc 400 or equivalent. 4 cr.

850. SEMINAR IN MOTOR LEARNING
Theoretical models of skill acquisition, motor skill taxonomies, and current issues in motor learning research. Prereq: PhEd 775 or equivalent. 4 cr.

895. ADVANCED STUDIES
Independent study problems. Prereq: permission of graduate adviser. May be repeated up to 8 cr. 2-4 cr.

899. MASTER'S THESIS
6 cr.
Physic (Phys)

Chairperson: Robert E. Houston, Jr.

ASSOCIATE PROFESSORS: John F. Dawson, Lennard A. Fisk, Jr., Harvey K. Shepard, Robert E. Simpson, John J. Wright
ASSISTANT PROFESSOR: Barry J. Harrington

Graduate Adviser: William R. Webber

The physics department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy in physics. Graduate students entering the Master of Science and Doctor of Philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that in the senior year at the University of New Hampshire.

Ph.D. students may demonstrate their preparedness for candidacy for the degree by one of two methods. The first of these methods is to prepare, at the beginning of the fall semester of the second year, a defense of an appropriate research topic. Exceptions to the timing are possible by petition. This topic must be defended in an oral presentation in which the physics involved is clearly demonstrated. Students must also be prepared to answer questions on basic physics in areas related to the main research topic. Each student will work in close cooperation with a committee of three, at least two of whom shall be from the physics department, in the selection, preparation, and defense of the selected topic.

The second method is to take a written qualifying examination. This examination will be given at the beginning of the fall semester of the second year. Exceptions to the timing are possible by petition.

Students are allowed a total of two attempts to achieve candidacy.

Master of Science Degree

For admission to graduate study leading to a Master of Science degree, students should have completed 24 to 30 semester hours in physics, or physics and closely allied fields. The courses required for the Master of Science in physics degree include Physics 833, 839, 841, and 843. Candidates may select one of the following plans:

1) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.
2) Complete 24 semester hours of courses chosen in consultation with the graduate adviser, complete a thesis representing the equivalent of 6 semester hours' work, and pass an oral examination on the thesis.

Doctor of Philosophy Degree

For admission to graduate study leading to a Doctor of Philosophy degree, students should satisfy the same general requirements as for a Master of Science degree. Admission to candidacy for the degree is primarily based upon demonstrated ability in formal coursework; experience in teaching, equivalent to at least half-time for one year; and the passing of a written examination or oral research topic defense as specified above. Finally, upon completion of a thesis, doctoral candidates will take an oral examination based upon the area of research.

The courses required for a Doctor of Philosophy degree in physics consist of: 1) 831-832, 833, 835, 839, 841-842, 843-844; and 2) any additional five full courses at the 800 level, excluding 889-890, 897-898, 899, and 999. (For students doing Ph.D. research in astrophysics or space physics, one of these five courses must be 850 or 852.)

Interdisciplinary Research

The department encourages research in areas related to physics or applied physics. Should students desire to do research in a field related to physics, special provisions may be made. Contact the department chairperson or graduate adviser for details.

607. PHYSICAL OPTICS
Electromagnetic theory of light, interference, diffraction, polarization, related phenomena, and nonlinear optics. Prereq: multidimensional calculus. 4 cr.

701-702. INTRODUCTION TO QUANTUM MECHANICS I AND II
Nonrelativistic Schroedinger equation, the hydrogen atom, applications to atomic and molecular structure; nuclear reactions and scattering; models of the nucleus; cosmic rays. Prereq: Calculus I; Calculus II; permission. 4 cr.
703-704. ELECTRICITY AND MAGNETISM I AND II
Foundation of electromagnetic theory; electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory, and an introduction to electrodynamics. Prereq: differential equations; multidimensional calculus; permission. 4 cr.

831-832. MATHEMATICAL PHYSICS
Complex variables, differential equations, asymptotic methods, integral transform, special functions, linear vector spaces and matrices, Green's functions, integral equations, variational methods, numerical methods, and tensor analysis. 3 cr.

833. EXPERIMENTAL PHYSICS I
Modern research techniques, including discussion and laboratory exercises in fundamental measurements in optics. Electromagnetism, nuclear and atomic phenomena. Prereq: passing an electronics proficiency test or basic experimental physics I. 3 cr.

834. EXPERIMENTAL PHYSICS II
Modern research techniques. Prereq: Phys 833. 1-3 cr.

835. STATISTICAL PHYSICS I
A 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. Prereq: Phys 831; Phys 843/or permission. 3 cr.

836. STATISTICAL PHYSICS II
Basic formulation and application of statistical mechanics to selected physical problems. Prereq: Phys 844. (Offered on request.) 3 cr.

839. THEORETICAL MECHANICS
Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 cr.

841-842. ELECTROMAGNETIC THEORY
The formulation and detailed application of electromagnetic theory to physical problems. Prereq: permission. 3 cr.

843-844. QUANTUM MECHANICS
Wave mechanical and Dirac formulations of nonrelativistic quantum mechanics. Prereq: permission. 3 cr.

850. PLASMA PHYSICS I
Topics to be discussed will be selected from the following: magnetohydrodynamics and plasma flow, waves, shocks and discontinuities, instabilities, and adiabatic motion of charged particles. 3 cr. (Not offered every year.)

852. PLASMA PHYSICS II
Topics to be discussed will be selected from the following: kinetic theory of plasmas, plasma waves, instabilities, and nonlinear plasma phenomena. Offered on request. Prereq: Phys 835/or permission. 3 cr.

861-862. ADVANCED QUANTUM MECHANICS
Relativistic wave equations, propagator theory and Feynman diagrams, quantum theory of radiation, second quantization, introduction to quantum field theory and related topics. Prereq: Phys 839; Phys 844. 3 cr. (Not offered every year.)

863-864. NUCLEAR PHYSICS
Introduction to nuclear processes, including nuclear forces, nuclear structure and models, static properties, beta and gamma emission, and nuclear reactions. Selected topics in experimental methods. Prereq: Phys 844. 3 cr. (Not offered every year.)

865-866. SOLID STATE PHYSICS
Development of quantum mechanical theory of solids, transport phenomena, etc. Prereq: Phys 843; Phys 835. 3 cr. (Not offered every year.)

887. COSMIC PHYSICS I
Topics will be selected from the following: ionospheric physics; magnetospheric physics; interplanetary physics; solar physics; cosmic ray physics; radio, x-ray, and gamma-ray astronomy; motion, transport, energy loss, origin, and acceleration of charged particles in the magnetosphere, interplanetary medium, and galaxy; cosmological problems. 3 cr. (Not offered every year.)

888. COSMIC PHYSICS II
Extended investigation of one or more of the topics introduced in Cosmic Physics I. Offered on request. 3 cr.

889-900. SPACE PHYSICS SEMINAR
Lectures and discussions of current research in the physics of fields and particles in space. 1-3 cr.

891, 892. PROBLEMS IN THEORETICAL PHYSICS
May be taken more than once. Offered on request. 3 cr.
Plant Science

893, 894. PROBLEMS IN EXPERIMENTAL PHYSICS
May be taken more than once. Offered on request. 3 cr.

895, 896. 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; relativity; group theory; atomic physics; quantum theory of light. May be taken more than once. 1-3 cr.

897-898. COLLOQUIUM
Required of all graduate students. Topics to be selected. 0 cr.

899. MASTER'S THESIS
6 cr.

999. DOCTORAL RESEARCH

Plant Science (PISc)

Chairperson: Lincoln C. Peirce

PROFESSORS: Gerald M. Dunn, Lincoln C. Peirce, Owen M. Rogers, Douglas G. Routley
ASSOCIATE PROFESSORS: George O. Estes, Yun-Tzu Kiang, David W. Koch, J. Brent Loy, James E. Pollard, Jerry Warren, Otho S. Wells
ADJUNCT ASSISTANT PROFESSOR: Merrill B. Hoyle

The graduate research program in plant science is concerned with solving basic and applied problems associated with growth of crop plants and their response to the environment. Facilities include laboratories, greenhouses, growth chambers, and two experimental farms.

The program emphasizes two principal disciplines: 1) breeding and genetics; and 2) physiology and biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding are major strengths complemented by University programs in genetics and statistics. A strong research and teaching program is also available in plant physiology, including advanced courses in plant nutrition, metabolism and growth and development. An increasing number of research projects in the department involve both geneticists and physiologists.

Undergraduates should obtain adequate background in the biological and physical sciences, including botany and chemistry. Students lacking these requirements may be admitted on condition that certain courses be completed without graduate credit. The Aptitude section of the Graduate Record Examination is required for application.

Candidates for the Master of Science degree will be required to prepare a thesis and to pass an oral examination. Candidates for the Ph.D. degree must take a written and/or oral qualifying examination and a final oral examination on the dissertation, in which the student must demonstrate ability to do original research in the area of specialization. Supervised teaching or its equivalent is required for each master's and doctoral student.

Advanced Plant Physiology

708. PLANT NUTRITION
Nutritional aspects of higher plants; uptake, translocation, and metabolic role. Prereq: plant physiology; soils. 4 cr. (Not offered every year.)

762. PLANT METABOLISM
Function, occurrence, synthesis, and degradation of plant constituents; respiration and photosynthesis; metabolism of nitrogenous and aromatic compounds; biochemical mechanisms in seed dormancy, fruit ripening, and disease resistance. Prereq: introductory biochemistry. 2 or 4 cr. (Not offered every year.)

863. PLANT GROWTH AND DEVELOPMENT
Biochemistry and physiology of growth and development; current research; independent laboratory projects. Prereq: plant physiology; biochemistry. 4 cr. (Not offered every year.)

Advanced Genetics (See Genetics Program)

705. POPULATION GENETICS
Population growth and regulation; distribution of genes; factors affecting gene frequency; genetic load; cost of natural selection; ecological genetics. Prereq: introductory genetics; introductory statistics/or permission. 4 cr. (Not offered every year.)

732. PLANT DEVELOPMENTAL GENETICS
Gene action in relation to development in plants; isozymes and differentiation; chromosomal proteins and gene regulation; temporal specificity of gene action; nuclear cytoplasmic interactions; chemical gradients and gene activation. Prereq: introductory genetics; physiology. 4 cr. (Not offered every year.)

740. EVOLUTIONARY BIOLOGY
The synthetic theory of evolution in the origin of life, species, and higher groups; sources of genetic variability; population structure; causes of evolution; evolution of communities; molecular evolution and rates of evolution. Prereq: introductory genetics or permission. 4 cr. (Not offered every year.)
773. METHODS AND THEORY OF PLANT BREEDING
Plant breeding systems for qualitative and quantitative plant improvement. Prereq: introductory genetics; introductory statistics/or permission. (Not offered every year.) 3 cr.

851. PLANT GENETICS
Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Prereq: genetics. 3 cr. (Not offered every year.)

853. CYTOGENETICS
Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Prereq: genetics; cytology. 3 cr. (Not offered every year.)

General Offerings and Independent Studies

720. LABORATORY TECHNIQUES IN PLANT SCIENCES
Use of laboratory instruments and techniques including extraction procedures, spectrophotometry, fluorometry, electrophoresis, chromatography, atomic absorption spectrophotometer, measurement of respiration and photosynthesis, photography, use of microscopes, and use of instruments for monitoring the environment. Prereq: chemistry (three semesters) or permission. 2 cr.

776. RADIOISOTOPE TECHNIQUES FOR LIFE SCIENCES
Application of radioisotopes to biological systems; detection and measurement, liquid scintillation spectrometry and autoradiography, gamma-ray spectrometry, radiochromatogram scanning, and tissue distribution of radioisotopes. Prereq: inorganic chemistry; physics. 4 cr.

795, 796. ADVANCED TOPICS IN PLANT SCIENCE
Independent research, study, or group discussion in the areas of physiology, genetics, or plant utilization. Prereq: permission. 2-4 cr.

877. SUPERVISED TEACHING FOR GRADUATE STUDENTS
Planning and presenting classroom and laboratory material. Biweekly seminars discuss teaching technique and problems. One credit or its equivalent required of each plant science master's and Ph.D. candidate. Plant science graduate students only. Prereq: permission. 1 cr. Cr/F.

895-896. RESEARCH IN PLANT SCIENCE
Advanced investigations in a research subject, exclusive of thesis. 1-4 cr.

897-898. GRADUATE SEMINAR
Library research and discussion of current topics of plant science. Required of all graduate students majoring in plant science. 1 cr.

899. MASTER'S THESIS
A thesis requiring study in depth of a phase in plant science. Required of all master's candidates in plant science. 6-10 cr.

999. DOCTOR OF PHILOSOPHY THESIS
Dissertation reflecting independent research in a phase of plant science is required. Credit received upon completion.

Political Science (Polt)

Chairperson: Lawrence W. O'Connell

PROFESSORS: Robert B. Dishman, Bernard K. Gordon, George K. Romoser, Allan A. Spitz

ASSOCIATE PROFESSORS: John R. Kayser, David L. Larson, David W. Moore, Lawrence W. O'Connell, B. Thomas Trout, Susan O. White, Frederic W. Wurzburg

ASSISTANT PROFESSORS: Warren Brown, Robert E. Craig, George K. Lagassa

Candidates for admission to graduate study in the Department of Political Science normally are expected to have majored either in political science or a field closely related, and to have achieved an undergraduate academic record of some distinction. In unusual and exceptional cases and where undergraduate preparation has been insufficient, candidates may be admitted provided that they follow without credit a program of study approved by the chairperson. In all cases the Graduate Record Examination is required of candidates who seek to be considered for admission. The department offers the Master of Arts in political science and the Master of Public Administration.

Master of Arts (M.A.) in Political Science

The program leading to the Master of Arts in political science is normally to be completed in a single calendar year (an academic year plus the following summer) and is based on three elements: the development of advanced knowledge in at least three fields of the discipline in which the department offers its courses and seminars; the ability to conduct and complete an individual program of research at a high level; and familiarization with modern methodology in the discipline. Accordingly, every candidate will complete a suitably arranged program consisting of eight courses and seminars (32 credits) and a master's thesis (which carries 4 credits), for a total of 36 credits. Of the eight
Political Science

courses, one must be Political Science 899, Sec. 1, Directed Research and Study, normally to be taken in the second semester of the candidate’s residence. The master’s thesis is expected to be within the field in which the candidate has undertaken Directed Study and Research, and generally is expected to derive from the same topic. Topics must be approved by a committee selected by the chairperson.

An essential requirement is that each candidate must arrange his/her program so that it includes at least one seminar (Political Science 897, 898) in each of three fields of the discipline emphasized by the department (political thought, American politics, comparative politics, and international politics). The remaining courses may be chosen according to the candidate’s interests and needs, and two may be taken in a related field outside the department. Where a candidate lacks proficiency in tools of quantitative analysis or a foreign language essential to the program of study and research, s/he will be required to attain and demonstrate to the thesis adviser proficiency in the needed skill.

Master of Public Administration (M.P.A.)

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 governments. Candidates will be expected to complete eight full courses (32 credits) and a six-week internship program, normally during the summer after the completion of formal course work. Candidates who have had prior appropriate responsibility in public administration may apply for a waiver of the internship requirement. A recreation and parks option which draws upon the resources of that department is offered as an interdisciplinary program for the degree. Students pursuing this option are held to the general degree requirements and usually take courses in recreation and parks to fulfill the requirements for work outside the political science department. The internship is served with an appropriate recreation and parks agency.

Of the eight courses, at least three shall be chosen from the courses and seminars in public administration offered by the department, and two from other political science courses offered by the department according to the needs and interests of the candidate. The remaining three courses may be chosen from outside the department in such related fields as economics, administration, resource economics, sociology, and recreation and parks.

Each candidate will be required to take Political Science 806: Theories and Processes of Public Administration; Political Science 807: Cases in Public Management; and Political Science 805: Methods of Policy Analysis. Candidates for the advanced degrees are expected to take courses at the 800 level in political science and to maintain a passing grade (B-) in all courses.

American Politics and Public Administration

701/801. THE COURTS AND PUBLIC POLICY
Impact of judicial decisions on public policy at federal, state, local and regional levels. 4 cr.

702/802. PUBLIC PLANNING AND BUDGETING
Analysis, goal setting, and strategic planning in a governmental setting, with particular emphasis on budgetary processes as a means for controlling policy effectiveness. 4 cr.

703/803. URBAN AND METROPOLITAN POLITICS
Planning and management of the ruban community, intergovernmental relations, administrative functions, and general urban policy problems. 4 cr.

797, 798/897, 898. SECTION 1: SEMINAR IN AMERICAN POLITICS
4 cr.

797, 798/897, 898. SECTION 2: SEMINAR IN PUBLIC ADMINISTRATION
4 cr.

805. METHODS OF POLICY ANALYSIS
Research design, survey methods, experimental techniques, and aggregate data analysis applied to public policy settings. 4 cr.

806. THEORIES AND PROCESSES OF PUBLIC ADMINISTRATION
Theories of organization and bureaucracy, the implications of bureaucratization, and the major processes of public administration including budgeting, personnel, policy making, as well as attention to contemporary policy issues including collective bargaining, affirmative action, citizen participation. 4 cr.

807. CASES IN PUBLIC MANAGEMENT
Policy case studies emphasizing politics, organizational structure, and interorganizational behavior; management case studies emphasizing behavior, human relations, personality, and intraorganizational dynamics; and simulation and role-playing exercises. 4 cr.

Political Thought

720/820. PERSPECTIVES ON POLITICAL SCIENCE
Different views on the study and meaning of politics. Perspectives of political scientists, political philosophers, and political activists. 4 cr.
721/821. ECONOMIC THOUGHT AND POLITICS
Economic theories from the perspective of political thought. Economic activity and resource distribution in relation to historical and contemporary issues such as freedom, equality, authority, community, democracy, and quality of life. 4 cr.

797, 798/897, 898. SECTION 3: SEMINAR IN POLITICAL THOUGHT
4 cr.

Comparative Politics

741/841. POLITICS OF INDUSTRIALIZED STATES
Impact of modern industrialism and its organization upon political life and the conduct of government. 4 cr.

742/842. COMPARATIVE COMMUNIST SYSTEMS
Interests, demands, and decision making in communist governments. Ideological issues, political behavior within communist international organizations, intraparty relations, distinctions between ruling and nonruling communist parties. 4 cr.

797, 798/897, 898. SECTION 4: SEMINAR IN COMPARATIVE POLITICS
4 cr.

International Politics

760/860. THEORIES OF INTERNATIONAL POLITICS AND INTEGRATION
General explanation of the behavior of nations; the theory and practice of supernational integration; theories of peace and security and community building at the international level; concepts and experience in arms limitation and conflict resolution. 4 cr.

761/861. INTERNATIONAL LAW
Formalized processes for regularizing state behavior; development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Arms reduction and limitation arrangements; inspections; and other formal procedures designed to preserve peace. 4 cr.

778/878. INTERNATIONAL ORGANIZATION
Collective security and other forms of cooperation among nations through international organizations such as the United Nations and its predecessors, and through regional bodies. 4 cr.

797, 798/897, 898. SECTION 5: SEMINAR IN INTERNATIONAL POLITICS
4 cr.

899. SECTION 1: DIRECTED RESEARCH AND STUDY

899. SECTION 2: MASTER'S THESIS

Related Courses in Recreation and Parks

For information contact Gus Zaso, Department of Recreation and Parks.

870. ADMINISTRATIVE INTERNSHIP
Practical administrative experience in an area of professional interest. Prereq: M.P.A. candidate—specialization in recreation and parks and permission. 4 cr. Cr/F.

885. COMPREHENSIVE PLANNING
Leisure and tourist planning—local, county, and regional. Recreation planning and resource development. Legislative aspects, court decisions, administrative organization, zoning, land use, and other master planning considerations. Prereq: permission of instructor. 4 cr.

890. SPECIAL TOPICS AND PROJECTS
Advanced study in specific areas; may involve formal classes, seminars, or independent projects. Prereq: permission of instructor. 4 cr.

Psychology (Psyc)

Chairperson: Ronald E. Shor

PROFESSORS: Raymond L. Erickson, Eugene S. Mills, John A. Nevin, Ronald E. Shor

Doctor of Philosophy

The Department of Psychology offers a four-year program of study leading to the Doctor of Philosophy degree. The basic goal of the program is the development of behavioral scientists who can both carry
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out sound research in an area of specialization and teach effectively. Integral to the program is the development of specific skills required by the research psychologist who intends to become a college or university teacher. In order to develop these skills, each year the program required of all students includes a variety of research and instructional activities in addition to the usual academic work. In the third year, each student teaches small sections of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its objectives an increased appreciation of the goals and problems of teaching.

Areas in which the student may specialize are: history and theory, learning, physiological psychology, perception-cognition, and social psychology. The student's adviser will help the students to plan an effective graduate program. Core courses taken by all students include methodology, statistics, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in the graduate courses listed below and by independent study and research conducted under the supervision of a staff member. Psychology 895, 896, Reading and Research in Psychology, is specifically designed to serve this purpose.

Prior to the doctoral dissertation, the student will carry out original research that culminates either in a master's thesis or a paper of publishable quality. A master's degree may be awarded upon the successful completion of a program approved by the department and dean of the Graduate School including original research at the master's level. Detailed information concerning the qualifying examination for advancement to candidacy for the Ph.D. degree and other requirements can be obtained from the department.

A student admitted to graduate study must meet the requirements for admission to the Graduate School. In applying for admission to the department's program, candidates must submit Graduate Record Examination scores on the verbal and quantitative sections of the admission test and the score on the advanced test in psychology.

To be accepted into the program, the applicant must desire to pursue the doctoral degree and be deemed qualified to do so on the basis of initial selection procedures. The applicant need not necessarily have been an undergraduate major in psychology. However, before beginning a graduate career proper, the applicant must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics and experimental psychology.

Graduate Curriculum in Psychology

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of the adviser, a program of research and study leading to the doctoral degree. The range and sequence of seminars will vary to some extent with each student, though there will be common features to all programs.

The 700-series psychology courses are not normally taken for graduate credit, though a student may be advised to enroll in one of these courses as a way of improving background in the field.

The core graduate courses are offered whenever possible in a two-year cycle. Consult the department for exact schedule.

801-802. GRADUATE PROSEMINAR
Students and graduate faculty in psychology meet every two weeks for a mutual exchange on current issues in psychology. 0 cr.

805-806. RESEARCH METHODOLOGY AND STATISTICS I, II
A consideration of research techniques and problems of methodology in psychology. The first semester stresses the principles of statistical inference, correlational approaches, and their interrelatedness in design. Topics considered include probability theory, linear regression, function-free prediction, the theory underlying statistical inference, parametric and nonparametric tests of significance, and principles of analysis of variance. The second semester extends the correlational approach to the techniques and methodology of multiple regression and considers the appropriate use and theoretical bases of complex designs. Prereq: undergraduate statistics and experimental psychology. 3 cr.

807. RESEARCH METHODS AND STATISTICS III
The application of multivariate methods of data analysis in psychological research: multiple regression, Hotelling's T^2, multivariate analysis of variance, discriminant analysis, canonical correlation, factor analysis. 3 cr.

812. PSYCHOLINGUISTICS
The use and development of human language: the nature of explanation, contemporary linguistic theory, semantics, functions of language, speech perception and production, learning. 3 cr.

814. COGNITIVE PROCESSES
The complex mental processes which characterize man: concept formation, reasoning, problem-solving, symbol use, creative thinking, imagination, fantasy behavior, pathology of thought consciousness and its alternatives, and the relationship between cognition and effective behavior. 3 cr.
817. **SENSORY AND PERCEPTUAL PROCESSES**  
Sensory psychology of visual and auditory reception; major problems of current interest. Students learn basic skills necessary to begin sensory-perceptual research. 1) physics of visual and auditory stimuli; 2) sensation and sensory systems; 3) basic visual and auditory psychophysics; and 4) study of complex perceptual processes, including pattern vision, color vision and color theory, depth perception, and auditory localization. 3 cr.

831. **PHYSIOLOGICAL PSYCHOLOGY I**  
Research methods and current concepts in the neurosciences. 3 cr.

833. **ADVANCED PHYSIOLOGICAL PSYCHOLOGY**  
Intensive examination of a specific topic in the neurosciences. Topics vary depending upon interests of instructor and students. Prereq: Psyc 831. 3 cr.

841. **PSYCHOLOGY OF LEARNING**  
Topics include conditioning and other forms of learning, with emphasis on current experimental and theoretical literature. Undergraduate preparation in the area is not required. 3 cr.

845. **ADVANCED RESEARCH TOPICS IN LEARNING**  
Current empirical and theoretical issues in learning. Prereq: Psyc 841 or equivalent. 3 cr.

850. **METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**  
Procedures, logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Experimental, quasi-experimental, and nonexperimental designs, the laboratory-field continuum, social psychological aspects of interviews and experiments, the nature of artifacts, and other current methodological issues. Emphasis on design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Prereq: Psyc 805, Soc 801, or equivalent. 3 cr.

851. **SOCIAL PSYCHOLOGY**  
A seminar covering current topics in experimental social psychology including attitude change, power and influence, interpersonal perception and attraction, conformity, and social learning. 3 cr.

852. **ATTITUDE AND ATTRIBUTION IN SOCIAL PSYCHOLOGY**  
Various approaches to attitudinal and attributional processes; emphasis on current theoretical issues. Prereq: Psyc 851. 3 cr.

853. **GROUP PROCESS AND SOCIAL INFLUENCE**  
Problems of the individual in the group and the group as a system; aspects of social influence. Prereq: Psyc 851 or permission. 3 cr. (Not offered every year.)

854. **SEMINAR IN SOCIAL PSYCHOLOGY**  
Intensive coverage of the experimental and theoretical literature in a selected area of basic or applied social psychology. Students will participate directly in the conduct of the seminar by means of individual topical discussions, development and/or execution of research designs, and critical assessment of the current state of the topic area under discussion. Illustrative topics: political behavior, paralinguistics and nonverbal communication, ethnic and racial prejudice, and environmental psychology. May be repeated for credit. Prereq: Psyc 851. 3 cr.

856. **PSYCHOLOGY OF PERSONALITY**  
Major theories and research in personality. 3 cr. (Not offered every year.)

871. **SURVEY OF THE HISTORY OF PSYCHOLOGY I**  
Overview of the history of psychology up to the mid-nineteenth century. 3 cr.

872. **SURVEY OF THE HISTORY OF PSYCHOLOGY II**  
Overview of the history of psychology from the mid-nineteenth century to the mid-twentieth century. 3 cr.

873. **METHODS AND THEORIES IN HISTORICAL RESEARCH ON THE BEHAVIORAL SCIENCES**  
Main methods and theories used in historical research applied to the study of the behavioral sciences. Prereq: Psyc 871, 872, or permission. 3 cr.

874. **PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY**  
In-depth studies of particular individuals, movements, and subfields. Each student pursues own research project. (May be repeated for credit.) Prereq: Psyc 871, 872, or permission. 3 cr.

875. **SPECIAL TOPICS IN THE HISTORY OF PSYCHOLOGY**  
Topic to be determined when course is offered. May be repeated for credit, Prereq: Psyc 871, 872, or permission. 3 cr. (Not offered every year.)

881. **CHILD PSYCHOLOGY**  
Devoted to topics of current interest in child psychology. Core material will be followed by in-depth study in an area of student's interest. 3 cr.
Sociology

891-892. PRACTICUM AND SEMINAR IN THE TEACHING OF PSYCHOLOGY
Practicum offers the student an opportunity to teach introductory psychology under close supervision from the staff. The seminar is coordinated with this experience and focuses on both practical and theoretical issues of significance in the teaching/learning process at the college level. Required of all doctoral students, typically during the third year. 5 cr.

894. ADVANCED RESEARCH IN PSYCHOLOGY
Student designs and conducts original research that culminates in a paper of publishable quality. Completion of either this course or Psyc 899 will satisfy the department’s requirement for the master’s degree. May be taken for 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr.

895-896. READING AND RESEARCH IN PSYCHOLOGY
As part of the development as an independent scholar, the student is encouraged to plan: 1) broad reading in an area; 2) intensive investigation of a special problem; or 3) experimental testing of a particular question. Requires approval of both adviser and staff member directing project. May be repeated. A) Physiological, B) Perception, C) History and Theory, D) Learning, E) Social, F) Cognition, G) Statistics and Methodology, H) Psychopathology, I) Developmental. 3-6 cr. per semester.

897-898. PROBLEMS AND ISSUES IN PSYCHOLOGY
Seminar on a problem which has been the subject of specialized research and study by a member of the staff. Topic and instructor vary. May be repeated. 3 cr. (Not offered every year.)

899. MASTER’S THESIS
Each student will carry out original research that culminates in a master’s thesis. May be taken 3 cr. per semester in each of two semesters or 6 cr. in one semester. Maximum 6 cr.

999. DOCTORAL RESEARCH

Graduate Courses Offered Primarily for Students Enrolled in Other Graduate Programs

823. INDIVIDUAL TESTING
Training in administration, scoring, and behavioral observation necessary for interpretation of individual tests of intelligence with discussion and demonstration of certain other instruments for cognitive measurement. The focus will be on children rather than adults, and on technique rather than interpretation. Each student will be required to purchase one set of materials. Lab. Prereq: permission. (Student’s background in statistics, measurement, exceptional child, and personality theory will be evaluated by the instructor.) 4 cr. to be granted only after the student has passed Psyc 825.

824. PRACTICUM IN INDIVIDUAL INTELLIGENCE TESTING
Supervised experience in use of individual intelligence tests in elementary and junior high school settings. Prereq: Psyc 823 or equivalent; permission. 2 cr. to be granted only after the student has passed Psyc 825 (may be taken concurrently or subsequently).

825. USE OF INDIVIDUAL INTELLIGENCE TESTS
Interpretation and use of individual intelligence test results in relation to the cognitive functioning of the child within the school setting. Taking into account background factors such as culture, emotional status, meaning of the test to the child, and ethical and administrative problems connected with interpreting test results to parents and school personnel. Students will have an opportunity to discuss case material from their actual daily work. Prereq: Psyc 823; Psyc 824, which may be taken concurrently; permission. 4 cr.

Sociology (Soc)

Chairperson: Richard E. Downs


ASSOCIATE PROFESSORS: Peter Dodge, Richard E. Downs, Fred Samuels, Howard M. Shapiro

ASSISTANT PROFESSORS: Charles Bolian, Loren Cobb, Gary Hume, Barbara Larson, Stephen P. Reyna

DIRECTOR OF GRADUATE STUDIES: Bud B. Khleif

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in sociology. The master’s program emphasizes theory and methodology. Doctoral students are expected to select from areas of departmental specialization one major area—and, from areas of expertise found among the faculty, one minor area—for intensive study and examination. Four major substantive areas for possible specialization are: deviance, conflict, and control; social psychology; comparative institutional analysis; family. In addition, a student may propose to the graduate committee another major area of specialization which falls within the faculty’s competence.
Proficiency in theory, statistics, and methods, and in the major and minor areas of study is determined by examination. Details about the examination can be found in the Graduate Student Handbook which is sent to all students requesting information about the program. Within the context of a curriculum organized largely in the form of seminars and research, the student is expected to select from departmental specializations one major area for intensive study, and also with the approval of the student’s adviser and the graduate committee to design a minor area suited to his/her specific interests from the balance of the curriculum offered by the department—including anthropology courses. In addition, evidence of satisfactory performance is required in an extradepartmental field that has been approved as appropriate to his/her professional development. The design of a program most suitable to the individual will take into consideration both the student’s past experience and intellectual goals, and, given the guidelines sketched above, flexibility will be emphasized. Selection of thesis and dissertation topics is thus limited only by the areas of expertise available among departmental faculty members.

Students are responsible for remaining informed about any modifications in the requirements of the degree program in which they are enrolled.

Master of Arts candidates must: 1) Complete satisfactorily at least one full year (24 credit hours) of graduate-level coursework in sociology including Sociological Methods I and II (801 and 802) and Sociological Theory I or II (811 or 812). 2) Register for one credit of thesis work during the second semester of residence and submit a draft of a proposal to the thesis committee by the end of the semester. The proposal or an abstract must be circulated to all department faculty. 3) Submit for approval a report of an original research endeavor to the thesis committee. This report may be in the form of either a) a thesis, or b) a paper in the form outlined in the publication format of any major sociological journal.

To be awarded the Doctor of Philosophy degree the candidate must fulfill the residence requirement of three years’ work after the bachelor’s degree including: 1) A minimum of 12 courses in sociology, other than thesis or dissertation research, including Sociological Theory I and II (811 and 812), Sociological Methods I and II (801 and 802), and one other course in methods or statistics (803 or 804); three courses in a major area, and two in a minor area of sociology. 2) A minor in a field other than sociology, consisting of three related courses. 3) Pass written examination in the major and minor areas of sociological specialization and in advanced theory and methodology. 4) Make an oral presentation of the dissertation proposal or other scholarly work to the department. 5) Demonstrate reading level proficiency in a foreign language or a research tool appropriate to the student’s program. Examples of 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. 6) Fulfill the research and/or teaching requirement described below. 7) Write and defend an acceptable doctoral dissertation.

In planning the program of study the student will be advised at first by an assigned faculty member and, subsequently, in the case of doctoral students, by a guidance committee. Specially appointed committees will be organized for the direction and assessment of the thesis and dissertation. Under such supervision the student is expected to go considerably beyond the minimal common requirements of the graduate program to establish a knowledgeability and competency peculiarly his/her own but the student will be permitted to take courses outside the department or below the 700-level within the department only with the express permission of the student’s adviser.

In all cases, a student having knowledge equivalent to any of the required courses may substitute an examination to be given by the faculty member responsible for the course.

An important part of the graduate program is the opportunity to learn from participation in the teaching and research activities of the department faculty. All candidates for doctoral degrees are therefore expected to assist a member of the department in teaching and/or research. Assignments to work with a specific member will be made by the graduate committee on the basis of the student’s experience, the needed areas of training, and the interests and preferences expressed by the students and faculty members.

Applicants for graduate study in sociology must meet all general Graduate School requirements and must present Graduate Record Examination scores on the aptitude tests and on the advanced test in sociology. Applicants for the Ph.D. should make available a copy of their master’s thesis to be reviewed by the Graduate Committee. Undergraduate majors in other fields may be admitted. 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 first complete the M.A. before admission to the Ph.D. program. The department welcomes both applicants who plan to continue for the Ph.D. and students planning for the M.A. only.

720. CURRENT DEVELOPMENTS IN SOCIOLOGY OF THE FAMILY
Topic will be selected each semester, such as stratification and the family, intrafamily communication, power structure of the family, kinship in modern societies. Critical review of the literature; class or individual research project will usually be carried out. Prereq: 8 credits of sociology; course in Family recommended. 4 cr.
721. FAMILY INTERACTION
Family interaction from a sociological perspective. Individual family members and relationships and the family as a unit considered using a social systems approach; and applied to analysis of one particular family. Prereq: intro. soc. or permission. 4 cr.

735. 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; impact of complex, formal organizations on persons and societies. Prereq: permission. 4 cr.

740. CULTURE CHANGE
Various types of society; development of theory. Descriptive studies of institutional as well as theoretical materials selected from the writing of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. Prereq: intro. soc. 4 cr.

741. 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 740 recommended. 4 cr.

745. SOCIAL STRATIFICATION
The pattern of distribution of economic, honorific, and political variables within the populations of complex societies; the allocation of personnel to the roles in question, notably through occupational mobility; and the impact of such processes upon behavior, both individual and social. Prereq: intro. soc. 4 cr.

757. SOCIAL INSTITUTIONS OF LATIN AMERICA AND THE CARIBBEAN
Selected analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prereq: permission. 4 cr.

761. POPULATION DYNAMICS
Major population trends including changes in birth and death rates, population characteristics, mobility, migration, world population growth, population problems, and policies of countries at different stages of economic development. Interrelationship of population and society. 4 cr.

770. CULTURE, PERSONALITY, AND SOCIETY
A cross-cultural view of the development of personality as emergent from genetic, situational, and sociocultural determination; analysis of the dynamic interplay of sociocultural and psychological behavior systems. Prereq: prior courses in sociology, anthropology, or psychology. 4 cr.

780. SOCIAL CONFLICT
The nature of social conflict, especially of war. The setting and initiation of conflict, its dynamics, and the factors affecting its course and outcome. Prereq: permission. 4 cr.

785. THE STUDY OF WORK
Understanding society through the structure of work. Case studies, in an ethnographic manner, of high-status and low-status occupations to provide understanding of social processes and interrelationships in the social structure. 4 cr.

790. APPLIED SOCIOLOGY
1) Current level of use of sociological knowledge; 2) the advocate, consultant, and researcher roles in applied settings; 3) techniques of applied research; 4) implications of applied sociology, including ethical problems. Each student will focus on a social problem and write a paper covering the above issues. Applied projects where possible. Prereq: Methods. 4 cr.

801. SOCIOLOGICAL METHODS I. INTERMEDIATE SOCIAL STATISTICS
Application of descriptive and inferential statistical methods to the analysis of sociological data, including sampling distributions, statistical decision-making, analysis of variance, correlation and regression, and nonparametric measures. Prereq: Statistics or permission. 4 cr.

802. SOCIOLOGICAL METHODS II. RESEARCH DESIGN
Systematic investigation of each step in the design and implementation of sociological research. Selected techniques of data collection and analyses will be pursued. Prereq: Methods of Social Research; Social Statistics; or their equivalents/or permission. 4 cr.

803. SOCIOLOGICAL METHODS III. SPECIAL PROBLEMS IN METHODS AND STATISTICS
Course alternates between special problems such as measurement or multivariate analysis. Prereq: Soc 802. 4 cr.
804. **SOCILOGICAL METHODS IV: FIELD WORK**
Training for participant observation in the manner of an anthropologist or Chicago-School sociologist. Students write and discuss field notes and become familiar with case studies, content analysis, and relevant issues. Field notes, basis for a term paper. 4 cr.

811. **SOCILOGICAL THEORY I**
The content presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prereq: History of Social Theory; Contemporary Sociological Theory; or their equivalents. 4 cr.

812. **SOCILOGICAL THEORY II**
The content, presuppositions, and implications of contemporary sociological theory. Students will engage in theory construction and analysis, and in this endeavor will be encouraged to develop their particular interests in substantive areas. Prereq: Soc 811. 4 cr.

813. **SOCILOGICAL 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: History of Social Theory; Contemporary Sociological Theory; or their equivalents. 4 cr.

821. **DEVIANT BEHAVIOR**
A seminar in which attention is directed to the relationships among cultural, subcultural, and personality variables and deviant behavior. Special emphasis is placed on the following forms of deviant behavior: invention, crime, alcoholism, and emotional illness. Prereq: permission. 4 cr.

830. **THE SMALL GROUP**
Sociological and social psychological perspectives on interaction within small groups. Prereq: courses in sociology and social psychology, or permission. 4 cr. (Not offered every year.)

838. **SOCIOLGY 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. (Also offered as Educ 838.)

850. **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. (Also offered as Psyc 850.)

851. **SEMINAR IN SOCIAL PSYCHOLOGY**
Some of the major themes in social-psychological theory, including social structure and personality, socialization, small-group processes, and interaction analysis. Students will be expected to read and evaluate selected empirical research. 4 cr.

852. **SOCIALIZATION AND ABNORMAL BEHAVIOR**
Orientation that relates socialization to abnormal behavior; synthesizes the major concepts into current sociological and social psychological frame of reference. Prereq: at least one course in social psychology or permission. 4 cr.

854. **SOCIOLGY OF RELIGION**
The reciprocal relationship of religion and culture; the function of religion in society; the contributions of sociological research; the relationship between religion and other social institutions; religion and social change; and the problem of church and state. 4 cr.

861. **DEMOGRAPHY**
Current problem areas in demography including population theory, formal demography, social epidemiology, social indicators, use of demographic sources and techniques in sociological investigation. Prereq: Soc 761 or permission. 4 cr.

870. **COMPARATIVE INSTITUTIONAL ANALYSIS**
Theory and methods of cross-national approaches, including: history, variations in objectives and methods, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prereq: permission. 4 cr.

875. **SOCIOLGY 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.

885. **OCCUPATIONS AND PROFESSIONS**
Professionalization as adult socialization, an acquisition of a new identity. Professions as ideologies, markets, and extended families. Research perspective of the Chicago School of Sociology. 4 cr.
The graduate program in zoology is intended for students who aspire to a professional career within or outside the area of college teaching and research. Degrees can be earned with emphasis in behavior, development, ecology (freshwater and marine), endocrinology, fisheries, genetics, invertebrate zoology, mammalogy, parasitology, and physiology.

To be admitted to graduate study in zoology, students ordinarily must have completed an undergraduate major in biology or zoology. A basic array of courses including general biology, development, general ecology, genetics, morphology, and physiology is normally required. Additionally, a background in chemistry through organic chemistry and a semester each of calculus and physics is necessary. Students who are deficient in any of these requirements may sometimes be admitted to graduate status but may be required to remedy their deficiencies by taking courses which do not give graduate credit. Applicants are requested to submit Aptitude and Advanced Biology scores for the Graduate Record Examination.

Each newly accepted graduate student will be interviewed during the second week of classes of the first semester. This interview will be conducted at a specified time by a committee composed of the student's temporary academic adviser plus two additional faculty members. The purpose of this committee is to advise the student in constructing a program of study and to correct such academic deficiencies as may exist. The committee will have available transcripts, letters of recommendation, and the results of the diagnostic exam described below. The committee will then enter its evaluation and recommendations in the student's permanent record.

All incoming graduate students will take a diagnostic exam before classes begin. This will include questions from the areas of behavior, biochemistry and physiology, development, ecology, evolution and systematics, genetics, morphology, parasitology, and general biology. No student is expected to do uniformly well in all areas, but rather a high level of competence is expected in those areas relevant to the student's particular program. Should the interview committee, on the basis of this exam, consider that a deficiency exists, this may be remedied either by a formal course or by an oral examination upon recommendation of the committee. Such oral examinations will be given during the week immediately following the spring vacation.

A candidate for the Master of Science degree in zoology, in addition to the requirements mentioned above, will ordinarily complete a special problem (Zool 895 or 896) or a thesis that is acceptable to the guidance committee.

All doctoral students must pass a written examination to certify their proficiency in one foreign language. Some fields of pursuit may require more languages and this need will be determined by the student's guidance committee.
After the successful completion of the language requirements and of all required courses, the student who wishes to be admitted to doctoral candidacy must demonstrate a broad basic knowledge of his/her major and minor fields in an oral qualifying examination, administered by the guidance committee. In addition, the student must convince his/her proposed major professor and doctoral committee, in whatever way the committee finds acceptable, of his/her superior capacity to carry out basic research in biology. Normally, the student may accomplish this by presenting to the committee a research proposal in which the soundness, originality, and feasibility of the investigative ideas are clearly revealed, and which—when approved—should serve as the basis of the doctoral dissertation.

704. COMPARATIVE ENDOCRINOLOGY
Endocrine organs; relationship to control of the internal environment, growth, development, and adaptation to the external environment. Prereq: vertebrate anatomy and physiology; organic chemistry. 4 cr.

706. GENETICS LABORATORY
Experiments and demonstrations in classical, developmental, and population genetics and cytogenetics, using a wide range of organisms and techniques. Pre- or coreq: principles of genetics or permission of the instructor. 2 cr.

707. HUMAN GENETICS
Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency. Prereq: principles of genetics or permission of the instructor. 4 cr.

711. NATURAL HISTORY OF COLD-BLOODED VERTEBRATES
Classes of poikilothermic vertebrates; their habits, habitats, and life histories in eastern North America. Prereq: general zoology; Vertebrate Morphology. 4 cr.

712. MAMMALOLOGY

713. ANIMAL BEHAVIOR
Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prereq: one year of zoology. 4 cr.

715. NATURAL HISTORY OF MARINE INVERTEBRATES
Field and laboratory course; inshore marine invertebrate metazoan animals of northern New England. Identification, classification, habitat preferences, and behavior. Work (collection and observation) constitutes a major part of the course. Some travel expense. Prereq: general zoology. 6 cr. Summer only.

717. GENERAL LIMNOLOGY
Special relationships of freshwater organisms to the chemical, physical and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prereq: General Ecology or equivalent. 4 cr.

719. FIELD LIMNOLOGY
Freshwater ecology examined through laboratory exercises with freshwater habitats. Methods to study freshwater lakes; interpretation of data. Seminars and occasional Saturday field trips. Prereq: present or prior enrollment in Bot 717 or Zool 717, or equivalent/or permission. 4 cr.

721. PARASITOLOGY
Introduction to the more important parasites causing disease in man and animals. Living materials will be used as far as possible. Prereq: one year of zoology. (Not offered every year.) 4 cr.

723. CELL PHYSIOLOGY
Principles of chemistry and physics applied to understanding cell structure and function. Metabolic reactions and their control in relation to cell organization; genesis and function of specialized cells. Prereq: Organic Chemistry. 4 cr.

724. MARINE PARASITOLOGY
Diseases and parasites of marine fishes and shellfish; emphasis on the local estuarine environment. Prereq: one year of zoology. (Not offered every year.) 4 cr.

730. VERTEBRATE HISTOLOGY
Microscopic anatomy of vertebrate tissues and organs at the light microscope level; emphasis on mammalian histology but with some comparative study of lower vertebrates. Lab. Prereq: Human Anatomy and Physiology; Vertebrate Morphology or equivalent. 4 cr.

732. SOIL ZOOLOGY
Faunal communities of terrestrial soils, their ecology and natural history. Effects of animal activities on soil processes and composition. Collection, extraction, and study methods. Independent projects. Prereq: General Ecology. (Not offered every year.) 4 cr.
740. BIOLOGY OF ANIMAL REGENERATION
Principles of regeneration in various animal phyla. Discussion of experimental studies supplemented by laboratory work with living animals. Prereq: prin of zool. 4 cr. (Not offered every year.)

772. FISHERIES BIOLOGY
Information and techniques used by fisheries biologists. Emphasis on fish life history, ecology, and economics as related to management techniques. Prereq: Zool 711 or equivalent/or permission. 4 cr.

775. INVERTEBRATE EMBRYOLOGY
A comparative study of aspects of reproduction and early development in selected invertebrates, providing a classical approach to morphology of gonads, fertilization, cleavage, gastrulation and formation of larvae. Prereq: UNH Zoology 774 or Cornell Univ. Biol Sci 364 or Invertebrate Zoology. Daily lectures, labs and field work; guest lecturers. Summer only. 4 cr. Cr/F.

795, 796. SPECIAL PROBLEMS IN ZOOLOGY

803. 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.)

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.)

811. FRESHWATER ZOOPLANKTON ECOLOGY
Methods of sampling populations; factors regulating temporal and spatial distribution; trophic interactions of communities, role in nutrient cycle of lakes. Experimental techniques employed in field trips to freshwater habitats. Seminars examine current research. Prereq: general ecology and limnology, Zool 717, or equivalent; permission. 4 cr. (Not offered every year.)

815. POPULATION ECOLOGY
Evolution, genetic theory, differentiation, and functioning of animal populations. Prereq: permission. 4 cr. (Not offered every year.)

817. ZOOPLANKTON
Oceanic and estuarine populations: zoogeography, interrelationships and adaptations to pelagic life. Prereq: invertebrate zoology; permission. 4 cr. (Not offered every year.)

820, 821. ADVANCED INVERTEBRATE ZOOLOGY
Morphology, phylogeny, and natural history of the major invertebrate phyla. Prereq: intro. to invertebrate zool. or equivalent. 4 cr. (Not offered every year.)

822. PROTOZOOLOGY
General biology of protozoa: morphology, physiology, natural history, and economic importance. Prereq: Zool 721, 820, or permission. 4 cr. (Not offered every year.)

826. COMPARATIVE PHYSIOLOGY
A study of the nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prereq: Zool 723; permission. 4 cr. (Not offered every year.)

895, 896. ADVANCED STUDIES IN ZOOLOGY
Course sections for advanced work, individual or group seminar. May include reading, laboratory work, organized seminars, and conferences. Prereq: permission of department chairperson and staff concerned. (Sections are the same as those listed under Zool 795, 796.) Variable to 12 cr. (Limit of 12 cr. from sections of this course)

897, 898. ZOOLOGY SEMINAR
Reports on recent zoological literature. Subject fields are those listed under Zool 795, 796; not all areas available every semester. Required of graduate students in zoology. Staff. 0 cr.

899. MASTER'S THESIS
Prereq: permission of department chairperson and prospective supervisor. 6 cr.

999. DOCTORAL RESEARCH
Open to students who have declared their intention of proceeding to candidacy for the Doctor of Philosophy degree.
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Assistant Professor of Forest Genetics; Ph.D., University of California, 1974.

Allmendinger, E. Eugene (1958)  
Associate Professor of Naval Architecture and Associate Director of Marine Program; M.S., University of New Hampshire, 1950.

Amell, Alexander R. (1955)  
Professor of Chemistry; Ph.D., University of Wisconsin, 1950.

Amsden, Katherine (1967)  
Associate Professor of Physical Education; Ph.D., University of Southern California, 1967.

Anderson, Kenneth K. (1960)  
Professor of Chemistry; Ph.D., University of Minnesota, 1969.

Anderson, Franz E. (1967)  
Associate Professor of Geology; Ph.D., University of Washington, 1967.

Andrew, Michael D. (1966)  
Associate Professor of Education; Ed.D., Harvard University, 1969.

Professor of Resource Economics; Ph.D., University of Minnesota, 1959.

Annis, William H. (1962)  
Professor of Occupational Education; Ed.D., Cornell University, 1961.

Antonak, Richard F. (1975)  
Assistant Professor of Education; Ed.D., Temple University, 1975.

Arnoldy, Roger L. (1967)  
Professor of Physics; Ph.D., University of Minnesota, 1962.

Ashley, Charles H. (1969)  
Associate Professor of Education; Ed.D., Boston University, 1969.

Aspnes, John (1976)  
Assistant Professor of Electrical Engineering; Ph.D., Montana State University, 1976.

Babcock, Robert B. (1977)  
Assistant Professor of Education; Ph.D., University of Georgia, 1977.

Baker, Alan L. (1972)  
Assistant Professor of Botany; Ph.D., University of Minnesota, 1973.

Balkwill, David L. (1977)  
Assistant Professor of Microbiology; Ph.D., Pennsylvania State University, 1977.

Balling, L.C. (1967)  
Professor of Physics; Ph.D., Harvard University, 1965.

Professor of Mathematics Education; Ed.D., Harvard University, 1961.

Barker, Richard L. (1975)  
Program Leader 4-H Youth Development and Associate Professor of Occupational Education; Ph.D., Ohio State University, 1967.

Barlow, Robert F. (1962)  
Professor of Economics and Administration; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1960.

Barrett, James P. (1967)  
Professor of Forest Biometrics and Genetics; Ph.D., Duke University, 1962.

Batho, Edward H. (1960)  
Professor of Mathematics; Ph.D., University of Wisconsin, 1955.

Baum, William M. (1977)  
Assistant Professor of Psychology; Ph.D., Harvard University, 1966.

Beasley, Wayne M. (1957)  
Associate Professor of Materials Science; S.M., Massachusetts Institute of Technology, 1965.

Bechtell, Homer F., Jr. (1966)  
Professor of Mathematics; Ph.D., University of Wisconsin, 1963.

Forbes Professor of Management; M.B.A., Harvard University, 1946; C.P.A.

Bennett, Albert B. (1967)  
Associate Professor of Mathematics; Ed.D., University of Michigan, 1966.

Assistant Professor of Computer Science; Ph.D., Brown University, 1973.

Birch, Francis S. (1972)  
Associate Professor of Earth Sciences; Ph.D., Princeton University, 1969.

Bishop, Paul L. (1972)  
Associate Professor of Civil Engineering; Ph.D., Purdue University, 1972.

Blakemore, Richard P. (1977)  
Assistant Professor of Microbiology; Ph.D., University of Massachusetts, 1975.

Blanchard, Fletcher A., Jr. (1950)  
Professor of Electrical Engineering; M.S., Lehigh University, 1950.

Blanchard, Robert O. (1972)  
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Blickle, Robert L. (1938-41, 1946)  
Professor of Entomology; Ph.D., Ohio State University, 1942.

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Bogle, A. Linn (1970)  
Associate Professor of Botany; Ph.D., University of Minnesota, 1968.

Bonne, William E. (1962)  
Associate Professor of Mathematics; Ph.D., University of Washington, 1962.

Professor of Zoology; Ph.D., Florida State University, 1961.

Bothner, Wallace A. (1967)  
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Bowman, James S. (1971)  
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Boy, Angelo V. (1965)  
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Boynton, Jason E. (1966)  
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Braff, Allan J. (1965)
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Associate Professor of Business Administration; Ph.D., Columbia University, 1973.

Assistant Professor of German; Ph.D., University of Kansas, 1971.

Brown, Warren R. (1972)
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Assistant Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1971.

Bruns, Paul E. (1958)
Professor of Forest Resources; Ph.D., University of Washington, 1956.

Buckley, Walter F. (1971)
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Bullock, Wilbur L. (1948)
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Burg, John F. (1977)
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Byers, Gordon L. (1956)
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Callan, Richard J. (1969)
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Canon, Lance K. (1973)
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Carney, John J. (1973)
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Cariccelli, Thomas A. (1967)
Professor of English; Ph.D., Harvard University, 1966.

Carroll, John E. (1974)
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Carter, Gavin H. (1965)
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Casás, R. Alberto (1952)
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Celikol, Barbaros (1969)
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Chaltas, John G. (1967)
Assistant Professor of Education; Ed.D., Columbia University, 1957.

Chasteen, N. Dennis (1972)
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Chesbro, William R. (1959)
Professor of Microbiology; Ph.D., Illinois Institute of Technology, 1959.

Chu, Yen-hsi (1977)
Assistant Professor of Civil Engineering; Sc.D., Massachusetts Institute of Technology, 1972.

Chupp, Edward L. (1962)
Professor of Physics; Ph.D., University of California, 1954.

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

Clark, Ronald R. (1957)
Professor of Electrical Engineering; Ph.D., Syracuse University, 1963.

Clee, Jan E. (1967)
Professor of Organizational Development; Ph.D., Case Western Reserve University, 1967.

Cobb, Loren (1972)
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Cohen, Allan R. (1967)
Professor of Organizational Behavior; D.B.A., Harvard Graduate School of Business Administration, 1967.

Cole, Lawrence P. (1966)
Assistant Professor of Economics; Ph.D., Purdue University, 1969.

Collins, Walter M. (1951)
Professor of Animal Science and Genetics; Ph.D., Iowa State University, 1960.

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

Congdon, Robert G. (1952)
Adjunct Associate Professor of Psychology; Ed.D., Harvard University, 1961.

Copeland, Arthur H., Jr. (1968)
Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1954.

Corcoran, Ellen P. (1972)
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Corell, Robert W. (1957-60, 1964)
Director of UNH Marine Program, Sea Grant Program, and Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1964.

Craig, Robert E. (1966)
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Croker, Robert A. (1966)
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Crow, Garrett (1975)
Assistant Professor of Botany; Ph.D., Michigan State University, 1974.
Davis, James R. (1970)
Associate Professor of Psychology; Ph.D., University of Wisconsin, 1969.

Davis, Richard S. (1968)
Dean of the College of Engineering and Physical Sciences and Professor of Materials Science; Ph.D., University of Toronto, 1954.

Dawson, Carl (1970)
Professor of English; Ph.D., Columbia University, 1966.

Dawson, John F. (1968)
Associate Professor of Physics; Ph.D., Stanford University, 1963.

De Alba, Pedro A. (1977)
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Deporte, Michael V. (1972)
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Diefendorf, Jeffry M. (1976)
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Diller, Ann (1973)
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Diller, Karl C. (1972)
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Dingman, S. Lawrence (1975)
Assistant Professor of Water Management; Ph.D., Harvard University, 1970.

Dishman, Robert B. (1951)
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Dodge, Peter (1964)
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Downs, Richard E. (1962)
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Draves, David D. (1964)
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Associate Dean of the Graduate School and Professor of Resource Economics; Ph.D., Vanderbilt University, 1961.

Dunlop, William R. (1950)
Professor of Animal Science; D.V.M., V.S., Ontario Veterinary College, 1938.

Dunn, Gerald M. (1951)
Professor of Plant Science and Genetics; Ph.D., Purdue University, 1951.

Durgin, Owen B. (1951)
Professor of Resource Economics; M.A., University of New Hampshire, 1951.

Dumall, Edward J. (1966)
Director of the Division of Continuing Education and Associate Professor of Education; Ed.D., Oregon State University, 1953.

Edwards, Ruth S. (1966)
Assistant Professor of Music; M.M., Northwestern University, 1950.

Assistant Professor of Economics; Ph.D., University of Michigan, 1974.

Erickson, Raymond L. (1963)
Dean of the Graduate School, Director of Research, and Professor of Psychology; Ph.D., University of California at Los Angeles, 1962.

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

Fairchild, Thomas P. (1969)
Associate Professor of Animal Science and Genetics; Ph.D., University of Wisconsin, 1964.

Fan, Stephen S.T. (1962)
Professor of Chemical Engineering; Ph.D., Stanford University, 1962.

Farag, Ihab H. (1976)
Assistant Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1976.

Femald, Peter S. (1966)
Associate Professor of Psychology; Ph.D., Purdue University, 1963.

Fink, Stephen L. (1969)
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Fisher, G. Thomas (1969)
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Fisher, Lester A. (1968)
Assistant Professor of English; Ph.D., Brown University, 1976.

Fisk, Lennard A., Jr. (1977)
Associate Professor of Physics; Ph.D., University of California at San Diego, 1969.

Associate Professor of Spanish; Ph.D., University of Arizona, 1971.

Foret, John E. (1967)
Associate Professor of Zoology; Ph.D., Princeton University, 1966.

Forsyth, G. Alfred (1967)
Associate Professor of Psychology; Ph.D., Purdue University, 1967.

Fort, Marron C. (1969)
Associate Professor of German; Ph.D., University of Pennsylvania, 1965.

Foster, Bennett B. (1969)
Professor of Forest Resources; Ph.D., Duke University, 1966.

Francq, Edward N. (1965)
Assistant Professor of Zoology; Ph.D., Pennsylvania State University, 1967.

Freuder, Eugene C. (1977)
Assistant Professor of Computer Science; Ph.D., Massachusetts Institute of Technology, 1975.
Frost, Albert D. (1957)
Professor of Electrical Engineering; Sc.D.,
Massachusetts Institute of Technology, 1952.

Gadon, Herman (1964)
Professor of Administration; Ph.D.,
Massachusetts Institute of Technology, 1953.

Gaudard, Marie A. (1977)
Assistant Professor of Mathematics; Ph.D.,
University of Massachusetts, 1977.

Gaudette, Henri E. (1965)
Associate Professor of Geology; Ph.D.,
University of Illinois, 1963.

Geeslin, William E. (1972)
Assistant Professor of Mathematics; Ph.D.,
Stanford University, 1972.

Geoffrion, Leo D. (1975)
Assistant Professor of Education; Ph.D., Johns
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Gerhard, Glen C. (1967)
Associate Professor of Electrical Engineering;
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Gill, Gregory D. (1977)
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Gilmore, Robert C. (1952)
Associate Professor of History; Ph.D., Yale
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Glanz, Filson H. (1965)
Associate Professor of Electrical Engineering;
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Goffe, Lewis C. (1946)
Associate Professor of English; Ph.D., Boston
University, 1961.

Gordon, Bernard K. (1971)
Professor of Political Science; Ph.D., University
of Chicago, 1959.

Grant, Clarence L. (1952-58, 1961)
Professor of Chemistry; Ph.D., Rutgers University,
1960.

Graves, Donald H. (1973)
Associate Professor of Education; Ed.D., State
University of Buffalo, 1973.

Green, D. MacDonald (1967)
Professor of Biochemistry and Genetics; Ph.D.,
University of Rochester, 1958.

Greenwood, Peter H. (1977)
Assistant Professor of Resource Economics;
Ph.D., Brown University, 1974.

Assistant Professor of Civil Engineering; Ph.D.,
Purdue University, 1976.

Grishman, Alan (1967)
Associate Professor of Music; M.A., New York
University, 1967.

Grossman, Lois S. (1972)
Assistant Professor of Spanish; Ph.D., Rutgers
University, 1972.

Hadwin, Donald W. (1977)
Assistant Professor of Mathematics; Ph.D., Indiana
University, 1975.

Haendler, Helmut M. (1945)
Professor of Chemistry; Ph.D., University of
Washington, 1940.

Hageman, Elizabeth H. (1971)
Associate Professor of English; Ph.D., University

Hagstrom, Earl C. (1965)
Associate Professor of Psychology; Ph.D., Brown
University, 1957.

Hailey, Russell (1975)
Assistant Professor of Administration; Ph.D.,
Union Graduate School, 1974.

Hall, Francis R. (1964)
Professor of Hydrology; Ph.D., Stanford University,
1961.

Haney, James F. (1972)
Associate Professor of Zoology; Ph.D., University
of Toronto, 1970.

Hansen, Larry J. (1973)
Assistant Professor of Home Economics;
Ph.D., Florida State University, 1973.

Hapgood, Robert (1965)
Professor of English; Ph.D., University of
California, 1955.

Harrington, Barry J. (1975)
Assistant Professor of Physics; Ph.D., Harvard
University, 1975.

Harris, Larry G. (1969)
Associate Professor of Zoology; Ph.D., University
of California, 1970.

Harter, Robert D. (1969)
Associate Professor of Soil Chemistry; Ph.D., Purdue University, 1966.

Hebert, David J. (1967)
Associate Professor of Education; Ph.D., Kent
State University, 1967.

Heilbroner, Hans (1954)
Professor of History; Ph.D., University of
Michigan, 1954.

Henry, William F. (1952)
Professor of Resource Economics; M.S.,
University of Connecticut, 1942.

Herbst, Edward J. (1962)
Professor of Biochemistry; Ph.D., University of
Wisconsin, 1949.

Herold, Marc W. (1977)
Assistant Professor of Economics; Ph.D., University

Hettinger, Stanley D. (1965)
Assistant Professor of Music; M.M.E., Vander-
Cook College, 1966.

Hill, John L. (1964)
Professor of Wood Science and Technology;
D.F., Yale University, 1954.

Hochgraf, Frederick G. (1958)
Associate Professor of Materials Science; M.S.,
Cornell University, 1958.

Hockel, Harold W., Jr. (1955)
Professor of Forest Resources and Genetics;

Hof, Phyllis (1967)
Associate Professor of Physical Education;
Ph.D., University of Southern California, 1967.

Holder, Mary E. (1967)
Associate Professor of Home Economics; M.S.,
Michigan State University, 1949.
Holler, James B. (1963)
Associate Professor of Animal Science; Ph.D., Pennsylvania State University, 1962.

Homer, Cynthia L. (1977)
Assistant Professor of Education; Ed.D., Northern Illinois University, 1977.

Hoornbeek, Frank K. (1964)
Professor of Zoology and Genetics; Ph.D., Oregon State University, 1964.

Horning, James O. (1966)
Professor of Business Administration; Ph.D., University of Chicago, 1967.

Hosek, William R. (1967)
Professor of Economics; Ph.D., University of California at Santa Barbara, 1967.

Houston, Robert E., Jr. (1957)
Professor of Physics; Ph.D., Pennsylvania State University, 1957.

Howard, Cleveland L. (1969)
Associate Professor of Music; D.M.A., Boston University, 1969.

Hubbard, Colin D. (1967)
Associate Professor of Chemistry; Ph.D., University of Sheffield, 1964.

Hurd, Richard W. (1973)
Assistant Professor of Economics; Ph.D., Vanderbilt University, 1972.

Hynlon, Walter E. (1976)
Assistant Professor of Animal Science; V.M.D., University of Pennsylvania, 1970.

Ikawa, Miyoshi (1963)
Professor of Biochemistry; Ph.D., University of Wisconsin, 1948.

Irwin, Manley R. (1963)
Professor of Economics; Ph.D., Michigan State University, 1963.

Jacoby, Robb (1961)
Professor of Mathematics; Ph.D., University of Chicago, 1946.

Jahnke, Leland S. (1977)
Assistant Professor of Botany; Ph.D., University of Minnesota, 1973.

James, Marion E. (1955)
Associate Professor of History; Ph.D., Harvard University, 1955.

Jansen, Edmund F., Jr. (1969)
Associate Professor of Resource Economics; Ph.D., North Carolina State University, 1966.

Jellison, Charles A., Jr. (1956)
Professor of History; Ph.D., University of Virginia, 1956.

Jones, Galen E. (1966)
Professor of Microbiology; Ph.D., Rutgers University, 1956.

Jones, Paul R. (1956)
Professor of Chemistry; Ph.D., University of Illinois, 1956.

Jones, William R. (1962)
Professor of History; Ph.D., Harvard University, 1958.

Kaen, Fred R. (1973)
Associate Professor of Finance; Ph.D., University of Michigan, 1972.

Kaufmann, Richard L. (1963)
Professor of Physics; Ph.D., Yale University, 1960.

Kayser, John R. (1969)
Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1969.

Kennard, Jean E. (1975)
Professor of English; Ph.D., University of California at Berkeley, 1968.

Kertzer, Robert (1965)
Associate Professor of Physical Education; Ph.D., Michigan State University, 1965.

Khalid, Bud B. (1967)
Professor of Sociology and Education; Ph.D., Johns Hopkins University, 1957.

Kiaw, Yun Tzu (1970)
Associate Professor of Plant Science and Genetics; Ph.D., University of California, 1970.

Kimball, Roland B. (1963)
Professor of Education; Ed.D., Harvard University, 1958.

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Warren, Jerry A. (1971) Director of Academic Computer Activities, Associate Professor of Plant Science; Ph.D., Cornell University, 1960.

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Graduate School Calendar 1978-79

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8 a.m. Residence halls open
8 a.m. Classes begin
Graduate student registration
Last day to drop courses without $10 late drop fee
Last day to add courses without $10 late add fee
Last day to carry over 16 credits without surcharge, or for partial tuition refund on withdrawal
Midsemester—Last day to drop courses or withdraw without academic liability
Veterans Day holiday—no classes
Last day for final Ph.D. oral examination (December graduation)
Classes follow Friday schedule
7 p.m. Residence halls close
Thanksgiving holiday—no classes
8 a.m. Classes resume
Last day for presenting final copies of dissertation or thesis to the Graduate School for binding (December graduation)
Last day to take final examination for the master's degree
Reading days
Commencement
8 a.m. Semester I final exams begin
Final exams end

8 a.m. Classes begin
Graduate student registration
Last day to drop courses without $10 late drop fee
Last day to add courses without $10 late add fee
Last day to carry over 16 credits without surcharge, or for partial tuition refund on withdrawal
Midsemester—Last day to drop courses or withdraw without academic liability
Spring recess
8 a.m. Classes resume
Last day for final Ph.D. oral examination (May graduation)
Last day for presenting final copies of dissertation or thesis to the Graduate School for binding (May graduation)
Last day to take final examination for the master's degree
Reading days
8 a.m. Semester II final exams begin
Final exams end; 7 p.m. Residence halls close
Commencement

The University reserves the right to modify the calendar subsequent to printing.