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Bulletin of the University  
of New Hampshire

Graduate  
School Issue



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# The Graduate School 1976-77

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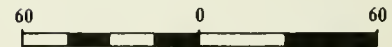
KEY



University System of N.H.



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# Graduate Degree Programs

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## Master of Science

Animal Sciences  
Biochemistry  
Biology  
Botany  
Chemical Engineering  
Chemistry  
Civil Engineering  
Electrical Engineering  
Entomology  
Genetics  
Geology  
Home Economics  
Mathematics  
Mechanical Engineering  
Microbiology  
Music Education  
Natural and  
    Environmental Resources  
Physical Education  
Physics  
Plant Science  
Zoology

## Master of Arts

Economics  
English  
German  
History  
Music  
Political Science  
Psychology  
Sociology  
Spanish

## Master of Arts in Teaching

## Master of Science for Teachers

Biology  
Chemistry  
English  
French  
Mathematics  
Physics  
Spanish

## Master of Occupational Education

## Master of Business Administration

## Master of Education

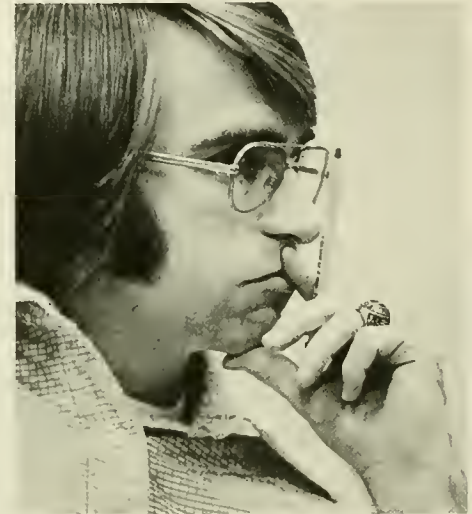
Administration and  
    Supervision  
Counseling and  
    Personnel Services  
Early Childhood  
Elementary Education  
Reading  
Secondary Education

## Master of Public Administration

Political Science

## Doctor of Philosophy

Biochemistry  
Botany  
Chemistry  
Economics  
Engineering  
English  
Genetics  
History  
Mathematics  
Mathematics Education  
Microbiology  
Physics  
Plant Science  
Psychology  
Sociology  
Zoology





# Graduate Education At the University of New Hampshire

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The University of New Hampshire awarded its first Ph.D. degree in 1896, placing it among the first American universities to award that degree. The development of doctoral programs in their present form began in the 1950s. The Graduate School was formally organized as part of the University structure over 40 years ago with the appointment of its first dean. The Graduate Council, composed of faculty and student representatives elected by their respective constituencies, serves in an advisory capacity. The graduate faculty supervises graduate study at the University.

The University of New Hampshire, guided by the quest for academic excellence, has followed a gradual, systematic approach in the development of graduate programs. The development of programs, which will be commensurate with institutional resources and the needs and opportunities found in New Hampshire and New England, has been the goal of this development. Coordination of programming among the units of the University System of New Hampshire is one of the considerations in all program development. The Graduate School has sought to avoid the pitfalls of overexpansion and has had significant success in placing its graduates in positions that utilize the skills acquired during their graduate study. The Graduate School cooperates with other graduate schools in New England to coordinate the further planning and development of graduate education in the New England region and participates in the New England Regional Student Program. (See p. 14.)

## Master's Programs

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The University offers master's degree programs in a wide variety of disciplines which serve both as professional, terminal degrees and as intermediate degrees 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 that they provide optimal educational opportunities in the state. In most programs students can elect options that will either permit them to study one aspect of a discipline in depth by preparing a thesis, or to gain a broader mastery of a discipline by electing to take course work in lieu of a thesis. While master's programs are generally 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. Recipients of the University of New Hampshire master's degrees have found employment in education, government, and business organizations in the state and nation; while others have been successful in further graduate study.

## Doctoral Programs

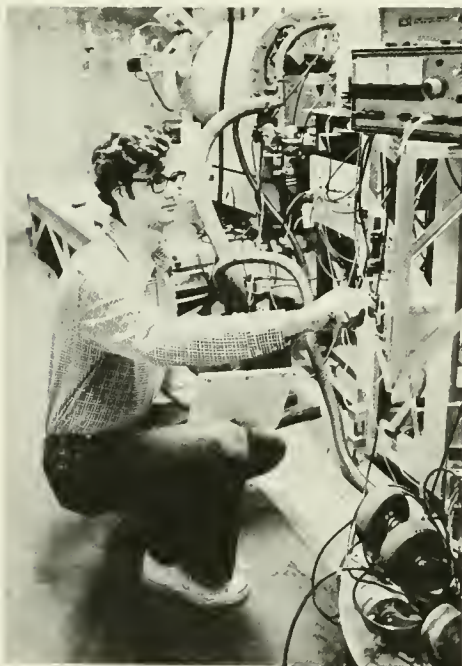
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The University offers Ph.D. programs in those disciplines where it has both faculty resources and facilities to support advanced graduate education of high quality. In developing doctoral programs care has been taken to ensure that the programs will

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 will find employment in higher education, most doctoral programs provide an opportunity for students to prepare for their role in higher education through work as teaching assistants and seminars in 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

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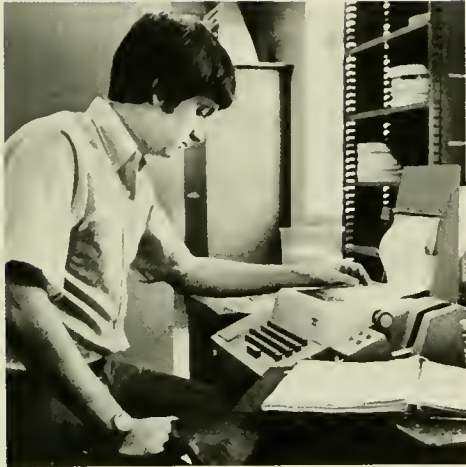
Many of the problems faced by modern society demand that students be trained in more than one of the traditional academic disciplines. Consequently, the Graduate School seeks to foster the development of programs which involve the faculty of more than one discipline or department. This may be done through 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, and soil and water 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.

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 soil and water science cooperating with chemistry faculty. 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 engineering, civil engineering, mechanical engineering, and chemical engineering departments.

Students in all programs are encouraged, with the consent of their adviser, to take those courses outside their discipline which are appropriate to their professional goals.

With its location on the New England coast near a variety of estuarine, coastal, insular, and continental shelf marine environments, the University has long had an





active interest in marine affairs. Within the University's Marine Program, master's and Ph.D. programs are offered in the areas of marine life, physical and social sciences, and ocean engineering on a departmental and interdisciplinary basis: marine life sciences—departments of biochemistry, botany, microbiology, and zoology; marine physical sciences, including chemical, geological, and physical oceanography—departments of chemistry and earth sciences; marine social sciences—the Institute of Natural and Environmental Resources, the Department of Political Science, and the Whittemore School of Business and Economics; and ocean engineering—departments of civil, chemical, electrical, and mechanical engineering. For further information, write to the UNH Marine Program Office, Kingsbury Hall.





# Teaching, Service, and Research

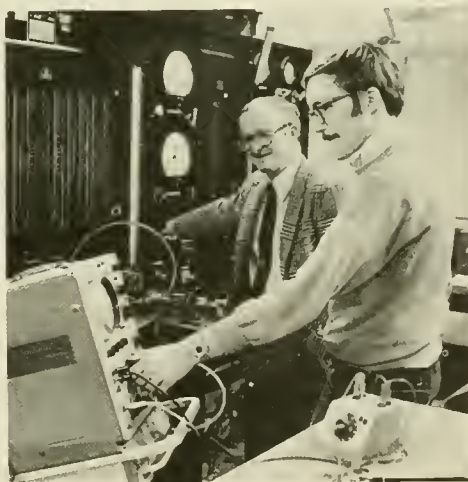
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Research provides a continuing transfusion of knowledge that enhances the level of instruction, extends the frontiers of knowledge, and makes human progress possible. Research is an essential ingredient of graduate education and provides an opportunity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

## Research and Service Facilities

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One of the largest research and service units of the University is the Agricultural Experiment Station which, in conjunction with the Cooperative Extension Service, provides research, information, and testing services for New Hampshire's agricultural industry. The Center for Industrial and Institutional Development, the Water Resources Research Center, and the Resources Development Center provide more specialized research and service to New Hampshire businesses, industry, and government. The Public Administration Service serves as a consultant group for town and city officials, and the Bureau of Educational Research and Testing serves New Hampshire educators. The service activities of all such units afford graduate students an opportunity to apply the skills acquired in their graduate programs.



**The Jackson Estuarine Laboratory** is an 8,400-square-foot structure located about five miles from the University campus on the shore of Great Bay at Adams Point. The tidewater area in the Great Bay estuarine complex covers more than 11,000 acres. Tidal water enters and leaves via the Piscataqua River; some 13.5 billion gallons ebb and flow on an average tide of eight vertical feet. The continental shelf of the Gulf of Maine is approximately thirteen miles by boat from the laboratory. Marine research facilities for the departments of biochemistry, botany, microbiology, zoology, and earth sciences are located in the laboratory. Also included are: a circulating seawater system; a small library-conference area; a research vessel, R/V *Jere A. Chase*; and a pier for docking research vessels.

Other marine facilities include the Diamond Island Facility on Lake Winnepesaukee and the Shoals Marine Laboratory, a joint facility of UNH, Cornell, and the State University of New York/Stonybrook, located on the Isles of Shoals about seven miles off the New Hampshire coast.

The Engineering Design and Analysis Laboratory interdepartmental faculty group and graduate students participate mainly in marine-oriented engineering projects. The Ritzman Animal Nutrition Laboratory and the Space Science Center offer sophisticated campus research facilities.

Among the other research instruments available on campus are mass spectrometers, an optical rotatory dispersion spectrophotometer, nuclear magnetic resonance spectrometers, a Van de Graaff generator, an amino acid analyzer, electron microscopes, a gas chromatograph, and an electron spin resonance spectrometer. Currently a DECsystem-10 comprises the principal facility for the University Computational Services Center. Students from all disciplines may make arrangements for its use.

**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 educational programs. Facilities include a closed circuit TV system which permits conference programs to be reviewed in the participants' rooms.

## Library

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The University Library houses over 700,000 volumes, 5,400 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 A-V 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.

The Dimond 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, Financial Aid, Academic Regulations

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## Admission

### Requirements

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, religion, or national origin in its admission and financial aid processes, in accordance with Title VI of the Civil Rights Act of 1964 and Title IX of the Education Amendments of 1972.

Applicants for admission must present evidence that they have had the necessary prerequisite training 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 undertaken with a record which is equivalent to that required for graduate students to remain in good academic standing at the University of New Hampshire.

Individual departments may specify special requirements which applicants must meet; such requirements may include the scores received on the aptitude and appropriate advanced sections of the Graduate Record Examination or the Aptitude Test for the Graduate Study of Business, 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 seeking admission to programs leading to the Master of Science for Teachers degree must meet 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 annually exceeds the number which can be accommodated by the University faculty and facilities. Thus, in some instances, otherwise qualified applicants may be denied admission because of these constraints.

A student who wishes to pursue a degree or program other than that to which admission was granted 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.

Master's candidates who intend to go on to 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. A student who has received the master's degree before applying for admission to study for the Ph.D. degree will be required to submit a new application.

## Application Procedures



An applicant for admission must submit directly to the dean of 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 copies of official transcripts 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 and fitness for graduate work, e.g., previous instructors or co-workers of the applicant. Letters must be forwarded directly by the referee to the Graduate School. Material from college placement offices not prepared within the last twelve months is not acceptable.
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 not be more than five years old.
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 forwarded to the appropriate department for review and recommendation. This review normally is conducted by a departmental committee composed of graduate faculty members. The Graduate School carefully reviews the applicant's file and the department's recommendation. After making the final decision, the Graduate School will inform all applicants of the action taken upon their applications.

Since the specific criteria for admission are different for each program in the Graduate School, it is impossible to itemize all of the factors which are weighed in the admission process. Because of this, the Graduate School has not established such specific criteria as the minimally acceptable scores on a standardized test, e.g. the GRE or GMAT. All of the material which is submitted as part of an application will receive careful consideration.

A New England resident enrolling in a graduate program offered at one of the New England state universities but not at the state university in the student's home state is eligible for in-state tuition rates under the New England Regional Student Program. Application procedures are contained 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.

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## Applicants from Foreign Countries

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 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.

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## Application Dates

Completed applications and supporting documents should be submitted before July 15 for the first semester, before December 15 for the second semester, and before 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 must submit completed applications and supporting documents for admission and financial aid prior to February 15.

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## Types of Admission

**Regular Admission:** Regular admission may be granted to those applicants whose academic records and supporting documents suggest 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 who wish to register for courses, may do so with the approval of the instructor and dean of the Graduate School. Such students 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. Special students are not required to file an application for admission to the Graduate School.

If a special student is subsequently admitted to a degree program, a maximum of nine credits earned in the University System of New Hampshire as a special student may, upon recommendation of the department, be applied to that program. Ordinarily, the nine credits would be selected from courses completed or in process on the date when the official letter of admission is written.

**Applicants Not Admitted:** Applicants who are denied admission are advised that they may be reconsidered only if there is additional significant material furnished which was not available at the time of the original decision, such as: evidence of additional 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 for courses for graduate credit. Such seniors should follow the application procedure outlined above, 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 up to 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 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 for individuals who resign their positions.

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

## Financial Information

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### Course Charges and Fees

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—\$900 per academic year (\$450 per semester); nonresidents of New Hampshire—\$2,600 per academic year (\$1,300 per semester).

**1-8 Credits per Semester:** students are charged according to the number of credits for which they register. Residents—\$45 per credit; nonresidents—\$110 per credit.



**More Than 16 Credits per Semester:** 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 less credits.)

The above charges will apply to admitted graduate students enrolling for courses at the University at Durham during the academic year. Admitted graduate students planning to enroll for courses at the Merrimack Valley Branch, through the School of Continuing Studies, or during the summer session, should consult the relevant catalogs for information regarding fees. Any combination of courses taken at the University (Durham Campus), Merrimack Valley Branch, and Division of Continuing Education totaling nine credits or more requires full tuition payment. Any student registering separately at the University (Durham Campus), Merrimack Valley Branch, and Division of Continuing Education and who pays the per-credit-hour charge at the University (Durham Campus) or Merrimack Valley Branch or the course charge at the Division of Continuing Education will be subsequently billed, if any combination totals nine credits or more, an additional amount necessary to meet the full tuition charge.

**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 a period of 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.

## Thesis and In Absentia Fees



**Master's Students:** Master's students registering for thesis credits (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 registered for the required number of thesis credits and are on campus completing their thesis will pay a *Continuing Enrollment Fee* of \$100.00 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 Fee* of \$25.00 one month prior to the conferral of their degree. This fee 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 (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 Fee* of \$100.00 one month prior to the conferral of their degree.

A Memorial Union Fee of \$17.50 per semester and a student-services fee of \$5.00 per semester must be paid by all full-time admitted graduate students. Students registered for less 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 \$5.00 for New Hampshire residents or \$10.00 for nonresidents of New Hampshire.

Students may audit courses with the consent of their adviser and the instructor involved. *Regular fees will be charged for all audits.*

University supported graduate assistants receiving the full stipend may be exempted from the payment of course charges and academic fees during the academic year of their appointment and the following summer session. University supported graduate assistants receiving half the normal 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.

**Refund of Course Charges:** Three-fourths of the course charges will be refunded to a student withdrawing during the first four days of a semester, one-half after four days and within thirty, and none thereafter. Admitted graduate students, at present, receive their course charge bills approximately four weeks after registration. Students should be aware that even though they withdraw before receiving a course charge bill, their liability for course charges is governed by the above regulation.

## Financial Aid

### Assistantships and Fellowships



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.

Approximately 300 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.

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 involve assisting in research activities in the Agricultural Experiment Station. Stipends for first and second year graduate assistants are \$3000 per academic year. For students serving beyond two years as graduate assistants the stipend is \$3200 per academic year. University supported graduate assistants receiving the full 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 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.

**Project Assistants:** An assistant who aids faculty members in an externally-funded research project. Stipends for project assistants are \$3850 per academic year. Project assistants do not receive a tuition waiver, but are charged tuition at the rate of \$900 per academic year.

Full-time summer employment may be available for project assistants or graduate assistants. Assistants employed during the summer are paid up to \$600 per month for maximum of two months full-time employment. Students so employed are not normally permitted to register for summer session courses.

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

**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 one full course or doctoral research registration per semester. Stipends are negotiable up to \$5,000 per academic year according to the qualifications and duties of the student. Graduate

associates whose positions are entirely funded from University funds may have one half of the dissertation fee or course charge waived (at the appropriate resident/nonresident rate) upon recommendation of the employing department. Graduate associates whose positions are funded externally (e.g., research) will be assessed the full dissertation fee and course charges.

**Summer Fellowships for Graduate Assistants:** A limited number of Summer Fellowships is available for students who have held graduate assistantships involving teaching during a previous academic year. The stipend for summer study is \$750.

**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.

Up to 30 superior students may be granted tuition scholarships for the summer session. Applications may be obtained from the Graduate School Office.

**University of New Hampshire Fellowships:** A limited number of three-year "University of New Hampshire Fellowships" is 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 \$3000 for the first academic year, \$3200 for the second academic year, and \$3400 for the third academic year. In addition, the award provides \$750 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 departments.

**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.

**Dissertation Fellowships:** Dissertation Fellowships with stipends of up to \$3000 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.

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## Federally Funded Traineeships and Fellowships

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 \$3900 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.

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## Loan and Work-Study Programs

**National Defense 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 which 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 \$1000 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 \$2500 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.

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## 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 so numbered 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 some 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 Verrette House concerning the courses offered and course schedules. Students intending to graduate in September, 1976, must present dissertation or thesis to the Graduate School Office by August 13, the last day for final Ph.D. and master's examinations and completion of all degree requirements is August 20.

**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 his/her 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 their recommendation with the appropriate justification within one month of the conclusion of the course.

A grade of Credit (Cr.) will be given for complete and 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.

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. The burden of removing the incomplete grade rests with the student. This rule does not apply to the completion of the thesis.

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## Requirements for Master's Degrees

**General Requirements:** For the degrees of Master of Arts, Master of Arts in Teaching, Master of Business Administration, Master of Education, Master of Occupational Education, Master of Public Administration, and Master of Science, at least 30 credits must be earned, including a minimum of eight credits, not including thesis, in courses numbered 800-898. Courses numbered 600-699 cannot be used towards these master's degrees if the courses are given in the department awarding the degree. No more than 12 credits will be permitted in courses numbered 600-699. The major department will prescribe for its students the courses which make up the degree program. Somewhat different requirements obtain for the Master of Science for Teachers degree and it is recommended for this degree, as well as for all other master's degrees, that the appropriate departmental section of the catalog be consulted.

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 off the Durham campus. A student may present for transfer credit a maximum of six credits earned at another graduate school, provided that these





credits are of a grade of at least B or the equivalent. Credits transferred from another graduate school will count as part of the 12 credits which may be earned off the Durham campus. These 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 in not more than six years from 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 progress 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 examinations for the master's degree, and the time of these 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 and not otherwise provided for, are appointed by the dean of the Graduate School, upon the recommendation of the department concerned. The graduate dean is, *ex officio*, a member of all examining committees.

**Master's Thesis:** A thesis may be required of candidates for the Master of Arts or the Master of Science degrees. Consult the departmental statement for thesis requirements. The thesis must be approved by a committee, comprising the instructor under whose direction it was written and two other members of the graduate faculty nominated by the department chairperson and approved 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, subject to the approval of the student's adviser. 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 Cr. (credit).

The student 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.

Two copies of the approved thesis, ready for binding, shall be submitted to the Graduate School Office as soon after approval as possible but not less than one week

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## Requirements for Doctor's Degrees

before Commencement, together with a receipt for the binding fee from the University Bookstore. Most departments 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 is 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 department 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 and administering the qualifying 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 major department 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 concen-

tration 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 the qualifying examination has been passed and such language or proficiency requirements as are deemed desirable by the major department have been met. The proposed subject of the student's dissertation must be declared at the time of 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.

A copy of the completed dissertation must be made available to the dean of the Graduate School and 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 one week prior to Commencement, two copies of the approved dissertation, ready for binding, shall be turned in to the Graduate Office, together with a receipt from the University Bookstore for the binding fee.

Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. 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 his 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.

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## Registration Procedure

Students admitted to the Graduate School must have 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 prior to the beginning of classes each semester, and on the first day of the summer session. Consult the calendar in this catalog for the date of registration.

Preregistration is mandatory for all students other than newly admitted students, and takes place at the Registrar's Office approximately six weeks prior to the end of each semester. A \$10 fee is charged for not preregistering. 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.

**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.

**Full-time Graduate Students:** Full-time graduate students are those students who have received either a conditional or regular admission to the Graduate School and are enrolled each semester for sufficient course or thesis (899) credits to be liable for full tuition. Students registered for Doctoral Research (999) or Master's Continuing Enrollment fee 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.





# UNH and Graduate Life

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The University is located in Durham—one of the oldest towns in northern New England. Durham is a small town located in a semi-rural area which still retains abundant traces of its colonial past. Easy accessibility to Boston’s cultural opportunities (90 minutes to the south); the unsurpassed skiing, hiking, and scenery of the White Mountains (90 minutes northwest); and sandy beaches and rocky coast of New Hampshire and Maine (30 minutes east) make it an ideal location.

The University campus (156 acres in size) is surrounded by more than 3,000 acres of fields, farms, and woodlands owned by the University. An impressive building program has resulted in 35 buildings for teaching, research, and administration, and 21 residence halls for men and women. The beauty of the campus is enhanced by a stream flowing through a large natural area in the middle of the campus.

The Durham campus 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 the colleges and schools on the University campus at Durham, the University System of New Hampshire includes Keene State College, Plymouth State College, the Merrimack Valley Branch at Manchester, 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 80 undergraduate and 39 graduate programs. The student body includes 1000 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 developed more rapidly. University status was conferred in 1923.

## Graduate Student Life

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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. Five graduate students, elected by districts, serve in the







University Senate, which is the primary governing body in matters of undergraduate student conduct and academic decisions. Graduate students serve on such University-wide committees as the Research Council, the Teaching and Learning Council, and the University Academic Planning Committee.

Babcock House, the graduate student residence hall, has become an increasingly active center for both academic and non-academic 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 invited to participate in most undergraduate clubs and social organizations.

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## Recreation and Cultural Activities

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

Coordinated by the Office of Recreation and Student Activities, recreational programs are organized in three interrelated areas: men's, women's, and co-recreational intramurals; club sports; and leisure-time activities. During each season a variety of activities are offered.

Individual activities offered are swimming, skating, or jogging. Also available are racquet sports, such as tennis, squash, and paddleball. Students may also participate in team sports, such as crew, basketball, rugby, or volleyball.

Graduate students who elect to participate in open recreation or recreation programs are required to purchase a University recreation pass.

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 students and University organizations schedule lectures, concerts, plays, or films throughout the year. There is a charge for some events but many are free.

Each year UNH's celebrity series bring a colorful array of professional talent to the University. Offerings include classical, modern, baroque, jazz music, and programs centered on human communication, whether in song, dance, speech, or mime. A sampling of recent programs includes Ella Fitzgerald and the Tommy Flanagan Trio; the Hartford Ballet Company, the Portland Symphony Orchestra; National Theater of the Deaf; the New England Conservatory Ragtime Ensemble; and the Royal Shakespeare Company.

The Sidore Series brings provocative, well-known speakers and experimental programs throughout the year. Arthur C. Clarke, Christine Jorgensen, Dixie Lee Ray, and Daniel Schorr lectured as guests of the series last year.

University students perform frequently in concerts, recitals, and theatrical productions. These programs originate in the music, and speech and drama departments and are open for participation to graduate students. 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 AM-FM radio station, the student newspaper, offices for student organizations, and facilities for student film services.

The University Library has music listening rooms and a collection of more than 5,500 tapes and records. New Hampshire's educational television station, WENH-TV, broadcasts in-school programs for 110,000 young people, and, during evening hours, cultural and educational programs.

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## Student Services

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### Graduate School Office

The Graduate School office is available to assist graduate students in both academic and personal matters affecting their study at the University. The staff will assist graduate students 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 both graduate students and faculty. Students are urged to contact the office concerning any questions which may arise concerning the availability or applicability of various University sponsored student services to graduate students.

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### Graduate Student Residences

**Babcock House:** The graduate residence is designed to provide housing for single, 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 Theater, and the Memorial Union Building. For those students with cars, parking is provided in areas convenient to the building.

The structure consists of two six-story towers, connected at each floor by a common lounge and accommodates 180 men and women. The House has a large lounge with fireplace, two recreation rooms, a food-vending room, coin-operated laundry, TV room, luggage storage, individual mail boxes, and private room-telephones, if desired. The rooms are all single rooms allowing complete privacy for consultation with



students or faculty; and each 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. The rental charge for Babcock House is \$730 per student per academic year, subject to revision by the Board of Trustees.

A faculty resident and family live in a two-bedroom apartment on the ground floor. The faculty resident works with the House Council, composed of all graduate students planning cultural and social programs, and with individual students on a personal level.

The faculty resident, with the aid of two graduate resident assistants, carries out the administrative responsibilities of the house and is knowledgeable about University policies and available personal services.

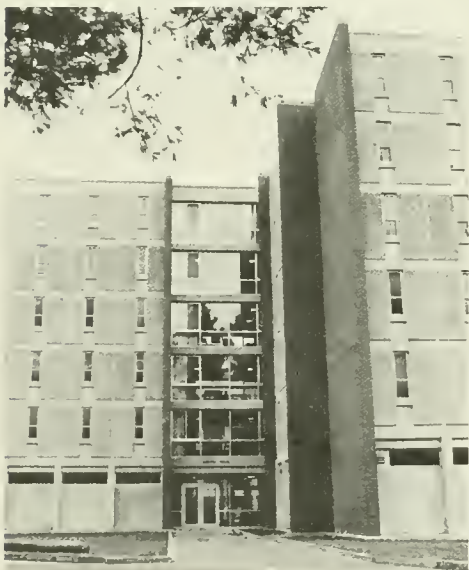
Residents provide their own bedding. An optional linen service is available which furnishes bed linen, towels, and blankets at a minimal cost.

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 for applicants whom it is impossible to house immediately.

**Forest Park Apartments:** The University owns and operates Forest Park, a complex of 154 studio (efficiency), 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 Durham shopping and school facilities. 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 containing the application blank and information concerning Forest Park is available upon request. Contact Forest Park Resident Manager, Apartment 11B, 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.



**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 in Stoke Hall, open Monday through Friday.

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## 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; none are available in individual rooms.

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## Counseling and Health Services



**University Health Service:** This service, located in Hood House, contains 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 spouse and children of students and University employees are not eligible for treatment at Hood House.

As a supplement to the Health Service program, an optional group accident and sickness insurance is available through the University Business Office.

**Counseling and Testing Center:** This agency, in collaboration with the Student Health Service at Hood House, is the primary mental health facility on campus. The center provides without charge, and through a professional staff, counseling to students who are experiencing personal difficulties or some disruption in their academic lives. Its services, which include individual and group counseling, are designed primarily to meet the typical needs of students who seek more personal and academic effectiveness.

The full- and part-time staff includes seven psychologists, two clinical associates, and six interns. A consulting psychiatrist is available for students whose needs go beyond the scope of the center's facilities. Individual testing is also available to help students establish goals, sort out their strengths and weaknesses, and assist in academic and career planning.

All information about students' visits to the center is confidential and is not released without permission.

During vacations and the summer, the center is only open on a limited basis.

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## Career Planning and Placement Service

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This service helps students to obtain professional employment upon graduation from the University. The services are available to students completing degree requirements and to alumni who have received degrees from the University in Durham. The Career Planning and Placement Service is located in Room 203 of Huddleston Hall.

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## Campus Minister and Churches

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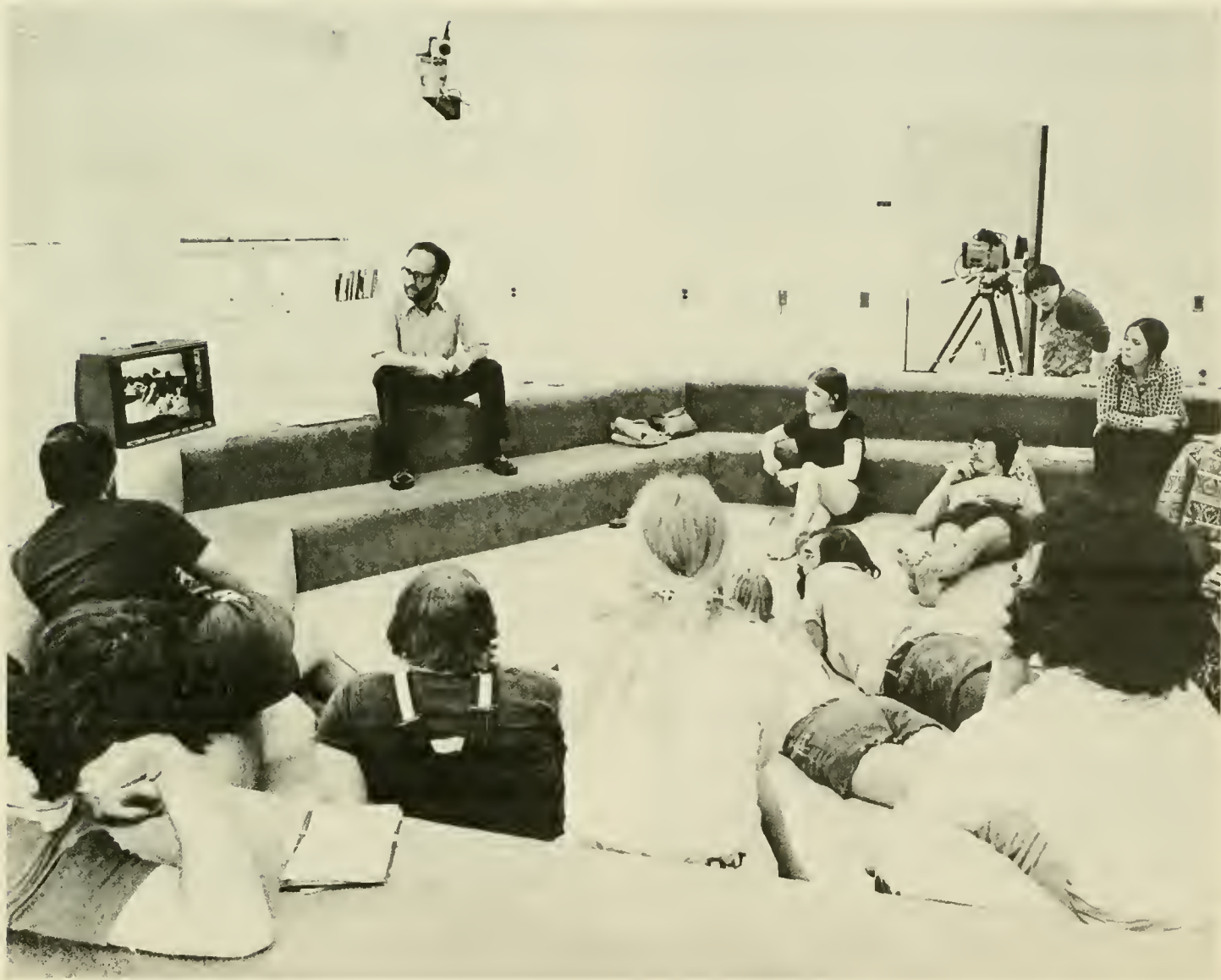
The Ecumenical Ministry to the University of New Hampshire is a cooperative endeavor involving a full-time on-campus minister; concerned administrators, faculty, and students; the designated denominational chaplains; and Durham residents. The Ecumenical Ministry focuses on issue-oriented programs, teaching, involvement in the needs and concerns of various members in the University, and counseling. In addition, there are specific organizations such as Hillel for Jewish students, the Inter-Varsity Christian Fellowship, the Fellowship of Christian Athletes, the Christian Science and Latter Day Saints groups and the Durham Unitarian Universalist Fellowship, which provides religious activities. In Dover are the Greek Orthodox Church and a Friends Meeting; Protestant, Catholic, and Episcopal churches are located in Durham.

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## The Alumni Association

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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* contains news of alumni, the University, students, and faculty.



# Departmental Requirements and Course Descriptions

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## Course Guide

The title and the Arabic numeral designate the particular course. Odd numerals indicate courses normally offered in the first semester; even numerals indicate courses normally offered in the second semester. Course numbers enclosed by parentheses indicate the course is offered out of sequence. If the course numerals are connected by a hyphen, the first semester, or its equivalent, is a prerequisite to the second semester. If the numerals are separated by a comma, properly qualified students may take the second semester without having had the first. NLG following the description indicates that the course carries no letter grade.

## Animal Sciences

**Chairperson:** W. C. Skoglund

**PROFESSORS:** Fred E. Allen, Walter M. Collins, William R. Dunlop, Winthrop C. Skoglund, Samuel C. Smith, Richard G. Strout

**ASSOCIATE PROFESSORS:** Allan C. Corbett, Thomas P. Fairchild, James B. Holter, James T. O'Connor Jr., Gerald L. Smith, Larry L. Stackhouse

**ASSISTANT PROFESSORS:** Frank Repka, Charles Schwab, Thomas Wight  
**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. The M.S. degree is offered in the areas of genetics, nutrition, physiology, diseases and parasites, and management. A thesis is required, and a candidate for the master's degree shall pass an oral examination covering the graduate courses and thesis. We encourage all students to obtain teaching as well as research experience during their graduate study.

### 701. PHYSIOLOGY OF REPRODUCTION

Physiology, embryology, endocrinology, reproduction, and lactation in domestic animals. Mr. Strout, Mr. Stackhouse. 3 lec/1 lab/4cr.

### 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. Squires. Prerequisite: AS 701 and permission of instructor. 3 lec/1 lab/4 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. (Also offered as HE 709.) Mr. Repka. 4 lec/4 cr.

### 710. RUMINANT NUTRITION

Feeding and management of dairy animals; calf feeding, raising young stock, feeding for economical milk production. Mr. Holter. 3 lec/1 lab/4 cr.

### 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. Prerequisite: 4 cr. of genetics or permission of instructor. Mr. Collins. 3 lec/1 lab/4 cr.

### 712. ANIMAL BREEDING AND IMPROVEMENT

Population genetics and selection in dairy cattle, livestock, and horses. Prerequisite: AS 711. Mr. Fairchild. 3 lec/1 lab/4 cr. (Alternate years; offered 1977-78.)

### 713. 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 histochemistry. Prerequisite: General Chemistry and permission of instructor. Mr. Wight. 3 lec/1 lab/4 cr.

### 795-796. INVESTIGATIONS IN DAIRY, LIVESTOCK, POULTRY

- 1) **Genetics:** Mr. G.L. Smith, Mr. Collins, Mr. Fairchild.
- 2) **Nutrition:** Mr. G.L. Smith, Mr. Holter, Mr. Repka, Mr. Schwab.
- 3) **Management:** Mr. G.L. Smith, Mr. Skoglund, Mr. O'Connor.
- 4) **Diseases:** Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. S.C. Smith, Mr. Stackhouse, Mr. Wight.
- 5) **Products:** Mr. G.L. Smith.
- 6) **Light Horses:** Mr. O'Connor, Ms. Briggs, Mr. Squires.
- 7) **Physiology:**

An opportunity is given for the student to 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. Prerequisite: AS 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. 3 lec/1 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. (Alternate years; offered 1976-77.)

**804. PROTEIN METABOLISM AND NUTRITION**

Metabolism of dietary amino acids in the mammalian system with emphasis on various aspects of protein nutrition. Prerequisite: permission of instructor. Mr. Schwab. 3 lec/3 cr. (Alternate years; offered 1977-78.)

**805-806. AVIAN MICROBIOLOGY**

The disease process (acute or chronic) in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Physiological and cytopathological changes in tissue culture. Prerequisite: AS 612 or the equivalent. Mr. Dunlop, Mr. Strout, and Mr. Corbett. 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. Prerequisite: histology or the equivalent. Mr. Dunlop and Mr. Strout. 3 cr.

**810. BIOCHEMICAL CO-FACTORS**

Designed to provide the student with an understanding of the significant role of the vitamins and trace minerals in metabolism in man and animals. Mr. Schwab. 2 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

**812. QUANTITATIVE GENETICS AND SELECTION**

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Prerequisite: 1 course each in genetics and statistics. Mr. Collins. 3 cr. (Alternate years; offered 1977-78.)

**851. CELL CULTURE**

Theory, principles fundamental to the culture 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. Prerequisite: Micro 503 and permission of instructor. (Also offered as Micro 851.) 2 lec/lab/4 cr.

**852. 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. Prerequisite: biochemistry, physiology, and vertebrate anatomy or permission of instructor. Mr. Wight. 3 lec/4 cr. (Alternate years; offered 1977-78.)

**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 and credits, from 6-10, to be arranged.

## Biochemistry

**Chairperson:** Gerald L. Klippenstein

**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.

A Master of Science degree candidate 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.

The Doctor of Philosophy degree candidate 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. Prerequisite: organic chemistry. Students receiving credit for Biochem 601 may not receive credit for Biochem 501. Mr. Ikawa. 3 lec/1 lab/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. Prerequisite: organic chemistry. Mr. Teeri. 3 lec/1 lab/4 cr.

## 702. COMPARATIVE MARINE BIOCHEMISTRY

Nutrition, metabolism, and composition of marine organisms and relation to phylogeny; marine natural products. Prerequisite: Biochem 601 or equivalent. Mr. Ikawa. 3 lec/3 cr. (Alternate years; offered 1977-78.)

## 721. NEUROCHEMISTRY

The biochemistry of the nervous system; metabolism and alterations of normal brain chemistry by drugs, chemicals, nutrition, memory, and learning; pathological changes. Prerequisite: biochemistry. Mr. Stewart. 3 cr. (Alternate years; offered 1976-1977.)

## 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. Prerequisite: one year of organic chemistry or permission of instructor. Mr. Klippenstein and Mr. Stewart. 3 lec/1 lab/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. 3 lec/1 lab/4 cr. (Alternate years; offered 1976-1977.)

## 770. BIOCHEMICAL GENETICS

The mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Prerequisite: Biochem 751 or permission of instructor. Mr. Green. 3 lec/1 lab/4 cr. (Alternate years; offered 1977-1978.)

## 781. THE NUCLEIC ACIDS

Chemistry and metabolism of nucleic acids; molecular structures, purification and separation, biosynthesis, and biological functions. Prerequisite: organic chemistry and biochemistry. Mr. Herbst. 3 lec/3 cr.

## 795,796. INVESTIGATIONS IN BIOCHEMISTRY

Subject matter and hours to be arranged. Prerequisite: permission of instructor. 2 cr.

## 811. BIOCHEMISTRY OF LIPIDS

The chemistry, metabolism, and function of lipids. Prerequisite: Biochem 752 or equivalent. Mr. Smith. 3 cr. (Alternate years; offered 1977-1978.)

## 832. BIOCHEMISTRY OF CARBOHYDRATES

The chemistry, metabolism, and functions of carbohydrates. Emphasis will be placed on polysaccharides, glycoproteins, and the nature of cell surfaces. Prerequisite: Biochem 601 or equivalent. Mr. Ikawa. 2 lec/2 cr. (Alternate years; offered 1976-77.)

## 842. BIOCHEMICAL REGULATORY MECHANISMS

The non-replicative 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. Prerequisite: a course in biochemistry. Mr. Stewart. 3 lec/3cr. (Alternate years; offered 1977-1978.)

### 850. PHYSICAL BIOCHEMISTRY

Structure, interactions, and physical properties of biomolecules. Thermodynamic, hydrodynamic, and spectroscopic methods for study of proteins and nucleic acids. Prerequisite: physical chemistry and biochemistry. Mr. Klippenstein. 3 lec/3 cr. (Alternate years; offered 1977-1978.)

### 852. ADVANCED BIOCHEMISTRY LABORATORY

Techniques for purification and characterization of proteins and nucleic acids. Prerequisite: Biochem 751. 2 lab/2 cr. (Alternate years; offered 1976-1977.)

### 897,898. BIOCHEMISTRY SEMINAR

Prerequisite: permission of the department chairperson. 0 cr.

### 899. MASTER OF SCIENCE THESIS

To be arranged. 6-10 cr.

### 999. DOCTORAL RESEARCH

## Biology:-Intercollege Biological Sciences Organization

**Chairperson:** Edward Francq

**Chairperson of Graduate Advising Committee:** Thomas G. Pistole,  
Department of Microbiology

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 and evolution; physiology; anatomy and nutrition; genetics; ecology; and pathobiology.

### Master of Science

This is a general, non-thesis 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, in-breadth 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 non-thesis 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

**Chairperson:** Robert Blanchard

**PROFESSORS:** Arthur Mathieson, Avery Rich, Richard Schreiber

**ADJUNCT PROFESSOR:** Alex Shigo

**ASSOCIATE PROFESSOR:** A. Linn Bogle

**ASSISTANT PROFESSORS:** Alan Baker, Robert Blanchard, Russell Kinerson, William MacHardy, Subhash Minocha, Garrett Crow

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.

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 which is to be a substantial contribution to botanical knowledge.

## Botany and Plant Pathology

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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; plant pathology, Mr. Rich, Mr. Blanchard, Mr. MacHardy, Mr. Shigo; plant morphology and anatomy, Mr. Bogle; mycology, Mr. Blanchard; cell biology, Mr. Schreiber; developmental botany, Mr. Minocha.

### **(606)606. PLANT PHYSIOLOGY**

Function of higher plants; water relations, metabolism, growth, and development. Prerequisite: Bot 411, 412, 503, or Pls 421 and one year of chemistry or permission of instructor. Mr. Minocha, Mr. Pollard. 3 lec/1 lab/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. Prerequisite: Bio 541 or equivalent. Individual projects. Mr. Baker, Mr. Haney. 3 lec/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. Prerequisite: prior or simultaneous enrollment in Bot 717 and permission of instructor. Mr. Baker and Mr. Haney. 2 lab/3 cr.

### **721. THE MICROSCOPIC ALGAE**

Survey of phytoplankton and periphyton in local marine and freshwater habitats. Identification, systematics, and evolution. Class and individual collection trips. Prerequisites: Bot. 411, 412 or 503. Mr. Baker. 2 lec/2 lab/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. Prerequisite: Bot 411, 412, or 502. Mr. Mathieson. 2 lec/2 lab/4 cr. (Alternate years; offered 1977-78.)

### **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. Prerequisite: Bot 722, Zoo 715, or permission of instructor. Mr. Mathieson. 2 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

### **724. FRESHWATER ALGAL ECOLOGY**

Survey of freshwater algal habitats, man's impact on algal communities of lakes and streams. Winter and spring field problems. Prerequisite: Bot 721 or permission of instructor. Mr. Baker. 2 lec/2 lab/4 cr.

### **730. MORPHOGENESIS**

Principles of differentiation; internal and external factors in cellular and organismic development. Prerequisite: Bot. 606 or permission of instructor. Mr. Minocha. 3 lec/1 lab/4 cr.

### **732. CELL BIOLOGY**

Structure, behavior, and development of cells; the cellular basis of heredity. Prerequisite: one year of biological science and chemistry. Mr. Schreiber. 3 lec/1 sem/4 cr.

### **(735). CELL PHYSIOLOGY (PLANT)**

Function of living cells, emphasis on algal cells. Prerequisite: one year of general chemistry and biological science. Staff. 2 lec/2 lab/4 cr. (Alternate years; offered 1976-77.)

### **741. ECOSYSTEM ANALYSIS**

Ecosystem structure and function; energy flow and biochemical cycles. Computer simulations of natural ecosystems. Prerequisite: Bio 541 or permission of instructor. Mr. Kinerson. 1 lec/1 lab/1 colloquium/4 cr.

### **742. PHYSIOLOGICAL ECOLOGY**

Physiological responses of plants to the physical environment; photosynthesis, water relations, mass and energy flow. Prerequisite: Bot 606 or permission of instructor. Mr. Kinerson. 1 lec/1 lab/1 colloquium/4 cr.

### **747. AQUATIC HIGHER PLANTS**

Flowering plants, fern relatives, and Bryophytes found in and about bodies of water in the northeastern United States; extensive field and herbarium work, preparation techniques, and collections. Prerequisite: Bot 566. Mr. Crow. 2 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

### **751. PLANT PATHOLOGY**

Nature, symptomatology, etiology, and classification of plant diseases. Prerequisite: Bot 411 or 412, or equivalent. Mr. Rich. 2 lec/2 lab/4 cr.

## 752. MYCOLOGY

Parasitic and saprophytic fungi; growth, reproduction, and identification; preparation of pure cultures. Prerequisite: Bot 411 or 412, or equivalent. Mr. Blanchard. 2 lec/2 lab/4 cr. (Alternate years; offered 1977-78.)

## 753. FOREST PATHOLOGY

Principles, etiology, epidemiology, and control of forest and shade tree diseases. Prerequisite: Bot 411 or 412, or equivalent. Mr. Blanchard. 2 lec/2 lab/4 cr.

## (754). PRINCIPLES OF PLANT DISEASE CONTROL

Exclusion, eradication, protection, immunization, and the specific practical methods used to control plant diseases. Prerequisite: Bot 751 or 753. Mr. MacHardy. 2 lec/2 lab/4 cr. (Alternate years; offered 1977-78.)

## 758. PLANT ANATOMY

Anatomy of vascular plants, emphasizing structure and development of basic cell and tissue types, and of the major plant organs. Prerequisite: Bot 411, 412, or 503. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years; offered 1976-77.)

## 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. Prerequisite: Bot 411, 412, or 503. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years offered 1977-78.)

## 764. MICROTECHNIQUE

Methods of preserving cell and tissue structure, embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Prerequisite: permission of instructor. Mr. Bogle. 2 lec/2 lab/4 cr. (Alternate years; offered 1976-77.)

## 767. ADVANCED SYSTEMATIC BOTANY

Principles and rules of plant classification and nomenclature; plant families; field and herbarium work. Prerequisite: Bot 566. Mr. Hodgdon. 1 lec/1 colloquium/1 lab/4 cr. (Alternate years; offered 1977-78.)

## 795-796. INVESTIGATIONS IN: 1) SYSTEMATIC BOTANY; 2) PLANT PHYSIOLOGY; 3) PLANT PATHOLOGY; 4) PLANT ANATOMY; 5) PLANT ECOLOGY; 6) MYCOLOGY; 7) CELL BIOLOGY; 8) PHYSIOLOGY; 9) BOTANICAL TEACHING; 10) MORPHOLOGY; 11) CELL PHYSIOLOGY; 12) SCIENTIFIC WRITING

Individual projects under faculty guidance. Elective only with permission of instructor. 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. Prerequisite: Bot 722 or its 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. Prerequisite: permission of instructor. Mr. Kinson. 4 cr. (Alternate years, offered 1976-77.)

## 851. CELL CULTURE

A consideration of the theory and principles fundamental to the cultures of cells in vitro. An introduction to the techniques of preparing and maintaining animal, plant, insect, and fish cell cultures. The application of cell culture to contemporary research in the biological sciences. Mr. Strout and staff, Mr. Metcalf, and Ms. Haugstad. Prerequisite: Micro 503 and permission of instructor. (Also offered as Micro 851 and AS 851.) 2 lec/lab/4 cr.

## 852. METHODS IN MYCOLOGY

Laboratory procedures employed in various aspects of mycological research from selection of research problem to journal publication. Prerequisite: Bot 752 or permission of instructor. Mr. Blanchard. 2 lec/open lab/4 cr. (Alternate years; offered 1976-77.)

## 853. ADVANCED PLANT PATHOLOGY

Advanced theories and methods in plant pathology. Mr. MacHardy. Prerequisite: Bot 751 or 753 and permission of instructor. Assigned reading, conferences. Lab/4 cr. (Alternate years; offered 1976-77.)

## 861. 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. Prerequisite: permission of instructor. Mr. Hodgdon. 1 lec/1 2-hr colloquium/field trips/4 cr. (Alternate years; offered 1976-77.)

## 895-896. INVESTIGATIONS IN: 1) SYSTEMATIC BOTANY, 2) PLANT PHYSIOLOGY, 3) PLANT PATHOLOGY, 4) PLANT ANATOMY, 5) PLANT ECOLOGY, 6) MYCOLOGY, 7) CELL BIOLOGY, 8) PHYSIOLOGY, 9) BOTANICAL TEACHING, 10) MORPHOLOGY, 11) CELL PHYSIOLOGY, 12) SCIENTIFIC WRITING

Individual projects under faculty guidance. Elective only by permission of the appropriate instructor. Hours to be arranged. 2-6 cr.

## Business Administration

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### 899. MASTER OF SCIENCE THESIS

6-10 cr.

### 999. DOCTORAL DISSERTATION

## Business Administration

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

**PROFESSORS:** Robert F. Barlow, John A. Beckett, Jan E. Clee, Stephen L. Fink, Herman Gadon, James O. Horrigan, John L. Korbel, Dwight R. Ladd, Robin D. Willits, Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Allan J. Braff, Dale G. Broderick, Allan R. Cohen, Russell Haley, R. Stephen Jenks, Richard L. Mills, Barry Shore, Linda G. Sprague, William E. Wetzell, Jr.

**ASSISTANT PROFESSORS:** John Burt, Fred Kaen, George Miaoulis

**INSTRUCTORS:** Dean Plager, Donald D. Wells

The Whittemore School day and evening programs leading to the degree of Master of Business Administration are designed to prepare graduates for professional careers in administration in both profit and not-for-profit organizations in a rapidly changing world. The MBA programs are 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 ever-changing society.

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

Candidates for admission must possess a bachelor's degree from an accredited college or university. In addition, all candidates are expected to take the Graduate Management Admission Test (GMAT) given by the Educational Testing Service. Details concerning 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 are of particular usefulness 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 day MBA program consists of an integrated sequence of 21 courses requiring two years of study which can be started only in the fall semester. During the first year, 13 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 a partly economic, legal, and social organization by requiring all students to complete the course, The Organization and its Environment.

The second year of the day program 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 seven 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.

The evening MBA program involves completion of 21 courses offered in an integrated sequence over 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 non-business undergraduate and is aimed at broad training rather than intensive specialization. It is comparable to the day MBA program in curriculum, but specially tailored to the content and scheduling needs of people working full time.

**Required Business Administration Courses** (day and evening MBA candidates): 800, 801, 802, 803, 804, 806, 808, 810, 811, 815, 816, 817, and 818.

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

### 705. OPERATIONS RESEARCH

Synthesis and analysis of mathematical decision models; mathematical programming, networks, inventory, queuing, scheduling, and Markovia models. Prerequisite: permission of instructor. 4 cr.

### **(712) 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. Prerequisite: permission of instructor. 4 cr.

### **713 (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. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 4 cr.

### **717. ADVANCED FINANCIAL ACCOUNTING**

Theory and practice as they contribute to the significance and limitations of the financial statements. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 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. Prerequisite: Admin 717 or permission of instructor. 4 cr.

### **722. ACCOUNTING SEMINAR**

Special topics. Prerequisite: Admin 717 or 718, depending on topics, and consent of instructor. 4 cr.

### **728. STATISTICAL DECISION-MAKING**

Probability and statistics applied to decision problems. Bayesian approach to decisions under uncertainty, which explicitly injects prior judgements of decision-makers and the consequences of alternative actions. Prerequisite: Admin 424 or equivalent. 4 cr.

### **730. INVESTMENTS ANALYSIS**

Capital market patterns and techniques useful for security analysis. Securities, market institutions, yield series, random walks, intrinsic-value analysis, and portfolio management. Security analysis research projects. Prerequisite: permission of instructor. 4 cr.

### **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 non-profit institutions. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 4 cr.

### **747 (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 Admin 651 or 808. 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. Prerequisite: a basic marketing course. 4 cr.

## Business Administration

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### 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. Prerequisite: Admin 651, 808, or permission of instructor. 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. Prerequisite: Admin 424 and 651 or their equivalent. 4 cr.

### 754. CONSUMER BEHAVIOR

Consumer-firm relationship; concepts from contemporary social science findings, particularly small group studies, learning, memory, cognition, motivation, emotion, perception concepts and global models related to present and prospective marketing activities of a business organization. Prerequisite: Admin 651 or permission of instructor. 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. Prerequisite: Admin 653 or 806. 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.

### 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. Prerequisite: permission of instructor. 4 cr.

### 798. SEMINAR IN ADMINISTRATION

Special topics; may be repeated. Prerequisite: consent of adviser and instructor. Variable 1-4 cr.

### 800. INTRODUCTION TO THE STUDY OF BUSINESS

Introduction to information sources and business institutions. Orientation in communication strategies and techniques. Identification of critical issues in economic organizations and approaches to business education. (All 800-level courses normally open to Master of Business Administration students only.) 2 cr.

### 801. STATISTICS

Basic mathematical and statistical concepts useful in managerial decision making. Probability, statistics, decision trees, and mathematic models. Emphasis is on applications. 3 cr.

### 802. MODELS FOR ANALYSIS AND DECISION MAKING

Synthesis and analysis of models as aids in describing systems and in making effective management decisions. System definition, conceptualization, formulation, data collection, validation, analysis, and managerial implementation. Qualitative as well as mathematical models are covered. 2 cr.

### 803. HUMAN BEHAVIOR IN ORGANIZATIONS

To provide students with an understanding of behavioral science concepts and their use in the analysis of individual, group and leadership relationships in organizations, and to develop 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.

### 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. 2 cr.

## 818. MANAGERIAL ECONOMICS

An economics approach to the conceptualization, analysis, and management of revenues, costs, and profits. 2 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

The use and understanding of law as it applies to business judgement and policy decision-making. Emphasis on learning basic legal rules and their application. Areas considered include: contracts, corporations, agencies, partnerships, administrative agencies, commissions, and other related business matters. Case-method teaching with outside research. 4 cr.

## 861. THE PHILOSOPHY OF MANAGEMENT SCIENCE

A 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. 4 cr.

## Chemical Engineering

**Chairperson:** Stephen S. T. Fan

**ASSOCIATE PROFESSOR:** Stephen S.T. Fan

**ASSISTANT PROFESSORS:** Virendra K. Mathur, Gail D. Ulrich, Charles E. Wyman.

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 Chemical Engineering 813, 815, 816, and 823, is required for the Master of Science degree in Chemical Engineering. 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 72.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors 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. 3 lec/1 lab/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.

## 750. INTRODUCTION TO PROCESS SIMULATION AND OPTIMIZATION

Analysis and numerical simulation of controlled chemical systems. Laplace transforms. Transient responses. Solution of nonlinear equations. Simultaneous, ordinary differential equations; Runge-Kutta, Crank-Nicholson methods. Steady state optimization: linear programming, classical search techniques. Unsteady state optimization: Pontryagin's maximum principle. 3 lec/1 rec/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. 3 lec/1 lab/4 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; non-isothermal kinetics; heat and mass transfer in non-equilibrium, chemically reacting systems. 3 cr.

## 852. ADVANCED PROCESS DYNAMICS

Process dynamics for higher order processes and non-linear processes. Modeling of complex process by differential equations, linearizing non-linear elements, and adequately controlling the entire system. 3 cr.

## 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

**Chairperson:** Alexander R. Amell

**PROFESSORS:** Alexander R. Amell, Kenneth K. Andersen, Albert F. Daggett, Clarence L. Grant, Helmut Max Haendler, Paul R. Jones, Robert E. Lyle, Jr., James D. Morrison, Frank L. Pilar, Albert K. Sawyer, J. John Uebel, Charles M. Wheeler, Jr.

**ASSOCIATE PROFESSORS:** N. Dennis Chasteen, David W. Ellis, Gloria G. Lyle, Colin D. Hubbard, Charles W. Owen, James H. Weber.

The Department of Chemistry offers programs leading to three graduate degrees: Doctor of Philosophy, Master of Science, and Master of Science for Teachers. Entering graduate students (except for those desiring the M.S.T. degree) are expected to take proficiency examinations in chemistry to assist in starting the 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 which 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. Courses leading to this degree will normally be chosen from Summer Session and Summer Institute offerings and require 30 semester hours in courses approved by the department chairperson. Persons interested in this degree should confer with the chairperson.

## Interdisciplinary Programs in Chemistry

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

## Analytical Chemistry

### 762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

Theory, instrumentation, and application of methods such as atomic absorption, conductimetry, coulometry, emission spectrography, gas chromatography, polarography, potentiometry, and spectrophotometry to chemical analysis. Prerequisite: Chem 406; Chem 684 as a prerequisite or concurrently or permission of instructor. (Students must register for Chem 763 concurrently.) 3 lec/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.) 1 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.

### 831. ADVANCED ELECTRICAL METHODS

Techniques of chemical identification and analysis utilizing electrical instrumentation from the standpoint of both theory and application. Topics include controlled-current coulometry, A-C polarography, chronoamperometry, cyclic voltammetry, controlled potential coulometry. 3 cr.

### 832. CHEMICAL INSTRUMENTATION

The basic modules of chemical instrumentation, both electrical and optical. 3 cr.

### 833. CHEMICAL SEPARATIONS

The use of various separation techniques prior to analysis, and separations as a method of analysis are discussed. The application of statistics to chemical problems of analysis is covered. 3 cr.

## Inorganic Chemistry

### 774. INORGANIC CHEMISTRY

Basic theoretical concepts and their applications to inorganic reactions and compounds. Prerequisite: Chem 683; Chem 684 pre- or co-requisite; or permission of instructor. Undergraduates must take Chem 775 concurrently. 3 cr.

# Chemistry

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## 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. 1 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. Prerequisite: Chem 803 or permission of instructor. 3 cr.

## 848. ADVANCED INORGANIC CHEMISTRY IV

The theory and practice of X-ray diffraction and the determination of crystal structure. Prerequisite: Chem 803 or permission of instructor. 3 cr.

## Organic Chemistry

### 651-652. ORGANIC CHEMISTRY

Principal classes of organic compounds, aliphatic and aromatic, with emphasis on class reactions and structural theory. Prerequisite: Chemistry 404 or 406 or permission of instructor. Students receiving credit for Chem 651-652 may not receive credit for either Chem 545 or 547-548. Must be taken concurrently with Chem 653-654. 3 lec/3 cr.

### 653-654. ORGANIC CHEMISTRY LABORATORY

Laboratory exercise to accompany Chem 651-652. Must be taken concurrently with Chem 651-652. 1 lab/2 cr.

### 755. ADVANCED ORGANIC CHEMISTRY

Advanced stereochemistry, mechanisms and synthetic reactions; structure determinations and synthesis of complex molecules. Prerequisite: Chem 548 or 652 or permission of instructor. 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

Heterolytic and homolytic substitution and elimination reactions for preparing major functional groups. Permission of instructor. 3 cr.

### 812. SYNTHETIC ORGANIC CHEMISTRY II

Reactions for the preparation of functional groups. Special emphasis on carbonyl compounds. Must be taken concurrently with Chem 755. Permission of instructor. 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, organic sulfur compounds, and nitrogen heterocycles. 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. Prerequisite: general inorganic chemistry and general physics. 2 lec/2 lab/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. Prerequisite: Math 426, 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. Prerequisite: Math 426, Calculus II, and physics. Must be taken concurrently with Chem 683-684. 2 lab/2 cr.

**776. ADVANCED PHYSICAL CHEMISTRY**

Foundations of quantum theory, elementary quantum mechanics, theory of spectra, statistical thermodynamics. Prerequisite: Chem 683-684. 4 cr.

**778. CHEMISTRY OF LARGE MOLECULES**

Basic chemistry of high-molecular-weight compounds, including synthetic polymers and substances occurring in living systems. Elementary aspects of the structures, syntheses, and properties of large molecules and their roles in modern science, technology, and living systems. Prerequisite: 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. Prerequisite: 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. Prerequisite: 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. Permission of instructor. 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. The student will present and defend 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: (1) INORGANIC CHEMISTRY, (2) ORGANIC CHEMISTRY, (3) THEORETICAL ORGANIC CHEMISTRY, (4) PHYSICAL CHEMISTRY, (5) 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. Staff. Cr. to be arranged.

**999. DOCTORAL RESEARCH****Courses for the Master of Science for Teachers Degree**

The following courses usually are offered only in the Summer Session.

**781. THE TEACHING OF HIGH SCHOOL CHEMISTRY**

Contemporary subject matter in general chemistry; choice of experiments for laboratory and lecture demonstrations; and presentation and evaluation of teaching methods which are effective in stimulating students. 4 cr.

**782. MODERN INORGANIC CHEMISTRY FOR THE HIGH SCHOOL TEACHER**

The current concepts on such topics as fundamental particles, atomic structure, nuclear reactions, electronic configurations and orbitals,

chemical bonds, the periodic table, oxidation-reduction, acids and bases, energy relationships, and ionic reactions. 4 cr.

### 783. ANALYTICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS

The principles of ionic equilibria in qualitative and quantitative analysis. Experimental work in qualitative analysis using the semimicro technique. The experimental work in quantitative analysis acquaints the student with the principles, techniques, and calculations of gravimetric and volumetric determinations. Some experimental work involves the use of the spectrophotometer in quantitative analysis and of the glass electrode method of measurement of pH. 8 cr.

### 784. MODERN APPROACH TO ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS.

The structure and properties of organic compounds, including those of current interest and importance, such as natural and synthetic polymers, antibiotics, and medicinals. An understanding of the behavior of organic compounds will be based on the current theories of reactions. 8 cr.

### 785. PHYSICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS

The laws of chemistry and their application to physical and chemical changes. Prerequisite: college physics, algebra, and trigonometry. 8 cr.

### 786. RADIOCHEMISTRY FOR HIGH SCHOOL TEACHERS

The theory of radioactive decay, the effects of radioactive decay upon matter, and the methods and techniques of the detection of radioactive decay. The uses of radiotracers in research. Prerequisite: general chemistry and general physics. 4 cr.

### 787. LABORATORY TECHNIQUES IN CHEMISTRY

Modern methods for the separation, identification, and estimation of substances. Experiments will be designed to assist the teacher by providing new subjects for laboratory demonstrations and student projects. Prerequisite: analytical and organic chemistry. 4 cr.

### 788. ADVANCED ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS

Types of homolytic and heterolytic reactions of organic compounds and their relationship to organic structures, including configuration and conformation. Prerequisite: Chem 784 or its equivalent. 4 cr.

### 789. ATOMIC AND MOLECULAR STRUCTURE

The methods of determining atomic and molecular structure, including ultraviolet and infrared spectroscopy and radiochemistry. 4 cr.

## Civil Engineering

**Chairperson:** Robert P. Vreeland

**PROFESSORS:** Charles O. Dawson, J. Harold Zoller

**ASSOCIATE PROFESSORS:** Paul L. Bishop, Louis H. Klotz, Paul J. Ossenbruggen, Robert P. Vreeland, Tung-Ming Wang

**ASSISTANT PROFESSORS:** David L. Gress, Dennis J. O'Brien

**ADJUNCT ASSOCIATE PROFESSOR:** Gerald H. Batchelder

**GRADUATE COORDINATOR:** Tung-Ming Wang

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 interests. 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 nomination 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. Program areas within the department include sanitary and environmental engineering, soil mechanics, foundation engineering, structural design, structural mechanics, transportation and urban systems planning, and others.

Ph.D. programs are available through the Engineering Ph.D. Program within the College of Engineering and Physical Sciences. The Ph.D. is awarded in Engineering, and 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 on page 72.

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 non-majors. 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."

## 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. Prerequisite: Civ Eng 505. 3 lec/1 lab/4 cr.

## 711. COMMUNITY PLANNING

Social, economic, and physical factors; content and extent of desirable programs—including purpose and scope; preliminary survey; elements of land planning; the master plan; transportation and circulation systems; patterns of land use; legal, financial, environmental, and economic problems. Prerequisite: permission of instructor. 4 lec/4 cr.

## 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. Prerequisite: permission of instructor. 4 lec/4 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. Prerequisite: Civ Eng 620 and 665. 3 lec/1 lab/4 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. 1 lec/1 lab/2 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. Prerequisite: Civ Eng 643 or permission of instructor. 1 lec/1 lab/2 cr.

## 745. HYDROLOGY AND HYDRAULICS

Occurrence and physical effects of water on the earth; meteorology, ground-water runoff and stream-flow routing, open-channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. Prerequisite: Civ Eng 642. 4 lec/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. Prerequisite: Civ Eng 644. 3 lec/1 design period/4 cr.

## 747. WATER TREATMENT PLANT DESIGN

Concepts, principles, and theory of plant design using a water source for a particular city and developing a treatment system for that community. Prerequisite: Civ Eng 644. 3 lec/1 design period/4 cr.

## 748. SOLID WASTE DISPOSAL

Basic concepts and theory of collection and disposal systems. Design methods involved in disposal systems. Prerequisite: Civ Eng 643 or consent of instructor. 3 lec/1 design period/4 cr.

## 751. TRANSPORTATION PLANNING

Transportation demand forecasting techniques applied to regional and urban situations. Calibration and use of mathematical models for forecasting land use, trip generation, trip distribution, modal choice, and trip assignment. Prerequisite: Tech 601 or equivalent. 3 lec/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. Prerequisite: Tech 601 or equivalent. 3 lec/3 cr.

## Civil Engineering

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### 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. Prerequisite: permission of instructor. 4 lec/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. Prerequisite: Civ Eng 665, 682, and senior standing. 3 lec/1 design period/4 cr.

### 768. SEEPAGE THROUGH EARTH STRUCTURES

Groundwater flow, Darcy's law, flow nets, Dupuit's theory and application, conformal mapping techniques, confined flow, flow through earth and rock structures, seepage towards wells. Prerequisite: Civ Eng 642 and 665. 2 lec/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. Prerequisite: Civ Eng 682 and permission of instructor. 1 lec/1 design period/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. Prerequisite: Civ Eng 685. 3 lec/1 design period/4 cr.

### 790. INELASTIC STRUCTURAL DESIGN

A continuation of modern design theory; ultimate design of reinforced concrete; plastic analysis of steel structures. 4 lec/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. Prerequisite: Civ Eng 682 or permission of instructor. 3 lec/1 design period/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.

### 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. Prerequisite: Civ Eng 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. Prerequisites: Civ Eng 644 and Micro 503, or permission of instructor. 3 lec/1 lab/4 cr.

### 856. INDUSTRIAL WASTEWATER TREATMENT

Detailed consideration of the origin, characteristics, and treatment of industrial wastewater; the theory and application of unit operations unique to the treatment and disposal of industrial wastes. Prerequisite: Civ Eng 644. 4 lec/4 cr.

### 857. ADVANCED WASTEWATER TREATMENT

Theory, application, and evaluation of new processes and developing techniques in water and wastewater reclamation and reuse. Prerequisite: Civ Eng 746. 4 lec/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. Prerequisites: Civ Eng 746 and 856. 2 lec/2 lab/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. Prerequisite: permission of instructor. 4 lec/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. Prerequisite: Civ Eng 863 or equivalent. 4 lec/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. Prerequisite: Civ Eng 863 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. Prerequisites: Civ Eng 765 and Civ Eng 863. 2 lec/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 lec/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 non-circular sections. 4 lec/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 lec/4 cr.

**884. DYNAMICS OF STRUCTURES**

Analysis of structures subjected to dynamic loadings. Free and forced vibrations with one or multi-degrees of freedom. Effects of damping and inelastic action. Vibrations of beams and framed structures. Dynamic response of beams due to moving loads. 4 lec/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 lec/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 lec/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 lec/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**

Hours and cr., 6-9, to be arranged.

**Earth Sciences**

**Chairperson:** Herbert Tischler

**PROFESSORS:** Cecil J. Schnee, Herbert Tischler

**ASSOCIATE PROFESSORS:** Franz E. Anderson, Wallace A. Bothner, Henri E. Gaudette, Glenn W. Stewart

**ASSISTANT PROFESSORS:** Francis S. Birch, Wendell S. Brown, Theodore C. Loder, Paul A. Mayewski

**COORDINATOR OF GRADUATE PROGRAM:** Henri E. Gaudette

The Department of Earth Sciences offers graduate work leading to the degree of Master of Science. Several options are available within the earth sciences program, including geochemistry; igneous and metamorphic petrology; crystallography; geophysics; glacial geology; and chemical, physical, and geological oceanography. A student is expected to have at least a year each of college calculus, chemistry, and physics. Students lacking these requirements may be admitted but will be required to complete certain courses which do not give graduate credit. In applying for admission to the departmental program, students should submit their Graduate Record Examination scores. A candidate for the master's degree shall pass an oral or written examination covering graduate courses and thesis.

**725. IGNEOUS AND METAMORPHIC PETROLOGY**

Textural, mineralogical, and chemical analysis, and phase rule and phase diagram interpretation applied to petrogenesis. Prerequisite: ES 613, 614, or permission of instructor. 3 lec/1 lab/4 cr.

## Earth Sciences

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### 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. \$60 lab fee includes transportation and housing in the field. Prerequisite: permission of instructor. 1 lec/1 lab/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. Prerequisite: Math 428 passed or taken concurrently, ES 401, and one year of college physics; or permission of instructor. 3 lec/1 lab/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. 3 lec/1 lab/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 R/V *Jere A. Chase*. Prerequisite: permission of instructor. 3 lec/1 lab (optional)/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. 2 lec/1 lab/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. Prerequisites: Phys 408, ES 501 or permission of the instructor. 3 lec/1 lab and field projects/4 cr.

### 759. GEOLOGICAL OCEANOGRAPHY

Major geological features and processes of the ocean floor; geological and geophysical methods; plate tectonics. Prerequisite: ES 401, 501 or permission of instructor. 3 lec/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. Prerequisites: ES 401, 561, or permission of instructor. 3 lec/1 lab/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 ES 401 or equivalent.) 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: ES 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 ES 402 or equivalent.) 4 cr.

### 795. GEOLOGICAL PROBLEMS:

1) Areal Geology, 2) Geochemistry, 3) Geomorphology, Advanced, 4) Geophysics, 5) Glacial Geology, Advanced, 6) Groundwater Geology, 7) Historical Geology, Advanced, 8) Industrial Minerals, 9) Micropaleontology, 10) Mineral Fuels, 11) Mineralogy, Advanced, 12) Optical Crystallography, 13) Ore Deposits, 14) Paleontology, Advanced, 15) Petrology, Advanced, 16) Regional Geology, 17) Sedimentation, 18) Stratigraphy, 19) Structural Geology, Advanced, 20) Marine Geology, 21) Physical Oceanography, 22) History of Geology, 23) Earth Science Teaching Methods, 24) Senior Synthesis, 25) Chemical Oceanography.

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. 2 or 4 cr.

### 796. HONORS PROJECT

Independent research projects similar to ES 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. NLG.

### 813. X-RAY CRYSTALLOGRAPHY

Theory and practice of diffraction of X-rays by crystals; lattices, symmetry, and structure analysis. Prerequisite: ES 613, Mineralogy, or Physical Chemistry or equivalent. 3 cr.

**816. MINERALOGY OF CLAYS**

The mineralogic composition, structure and properties, origin and mode of occurrence of clay minerals and clay materials. Prerequisite: permission of instructor. 3 cr.

**820. ADVANCED IGNEOUS PETROLOGY**

Extensive readings and discussions of original sources and recent literature with reference to classical petrologic provinces. Application of thermodynamics and phase-rule chemistry to igneous petrogenesis. Prerequisite: graduate standing and permission of instructor. 3 cr.

**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. Prerequisite: graduate standing and permission of instructor. 3 cr.

**841. ANALYTICAL GEOCHEMISTRY**

Introduction to the theory, instrumentation, and applications of analytical methods in geochemistry. Prerequisite: permission of the instructor. 3 cr.

**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. Prerequisite: permission of instructor. 3 cr.

**858. DYNAMICAL OCEANOGRAPHY**

The hydrodynamics of such ocean phenomena as waves, tides, and ocean turbulence; wind driven circulation on the continental shelf and deep ocean, will be treated in detail. Prerequisite: ES 758, ME 707 or permission of instructor. 3 lec/4 cr.

**895,896. TOPICS IN GEOLOGY**

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

**897,898. SEMINAR IN CONTEMPORARY GEOLOGY**

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

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

6-10 cr.

## Economics

**Director of Economics Studies:** William R. Hosek

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

**ASSOCIATE PROFESSORS:** Allan J. Braff, William R. Hosek, Richard L. Mills, Robert C. Puth

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

**ASSISTANT PROFESSORS:** John Burt, Lawrence P. Cole, Philippe Deville, Richard Hurd, Fred Kaen, Heidemarie C. Sherman, 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.

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

## Economics

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### 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. Prerequisite: Econ 611 or permission of instructor. 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. Prerequisites: Econ 605 and 611 or permission of instructor. 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. Prerequisite: Econ 605, 611; or permission of instructor. 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. Prerequisite: Econ 605, 611, or permission of instructor. 4 cr.

#### 722. CASE STUDIES IN ECONOMIC DEVELOPMENT

Problems and policies in selected countries; evaluations of national plans, programs, and projects; comparative analysis. Sections: 1 Southeast Asia; 2 Cost-Benefit and Project Analysis; 3 Africa; 4 South America. Prerequisites: Econ 401, 402; or permission of instructor. 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. Prerequisites: Math 427-428 or equivalent. 4 cr.

#### 726. MATHEMATICAL ECONOMICS

Principal mathematical techniques and their application in economics. Prerequisite: permission of instructor. 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. Prerequisite: Econ 725 or permission of instructor. 4 cr.

#### 746. INTERNATIONAL FINANCE

International monetary mechanism; balance of payments; international investment; exchange rates, adjustment systems, international liquidity, foreign aid, multinational corporations. Prerequisite: Econ 401, 402. 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. Prerequisite: Econ 401, 402; or permission of instructor. 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. Prerequisite: Econ 605, 611; or permission of instructor. 4 cr.

#### 768. SURVEY OF URBAN ECONOMICS

Theoretical and empirical bases; policy alternatives for the problems of poverty, housing, urban renewal, transportation, local fiscal affairs, and pollution. Prerequisite: Econ 605 or permission of instructor. 4 cr.

#### 798. SEMINAR IN ECONOMIC PROBLEMS

Special topics; may be repeated. Prerequisite: permission of adviser and instructor. 2 or 4 cr.

**855. 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. 4 cr.

**856. LABOR ECONOMICS**

Recent developments in labor market analysis and public policies related to contemporary labor issues are discussed. Topics covered include labor supply, the structure and stratification of labor markets, economic discrimination, unemployment and poverty, inflation, and wage-price controls. 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.

**859. 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. 4 cr.

**860. 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. Prerequisite: permission of instructor. 4 cr.

**863. INTERNATIONAL ECONOMICS**

Contemporary issues in international economic theory and policy. Analysis of trade theory, dynamics of world trade and exchange, and international commercial policy. 4 cr.

**873. MACRO-ECONOMIC THEORY I**

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. MACRO-ECONOMIC THEORY II**

A continuation of Macro-economic Theory I in which the dynamics of the models are stressed and growth theory receives central attention. Prerequisite: Econ 873. 4 cr.

**877. MICRO-ECONOMIC THEORY I**

Topics in micro-economics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand theory, and capital theory. 4 cr.

**878. MICRO-ECONOMIC THEORY II**

A continuation of Micro-economic Theory I. The course will attempt to bring the student to the frontiers of contemporary research on selected problems of micro-economics. Prerequisite: Econ 877. 4 cr.

**890. ECONOMICS OF FINANCIAL MARKETS**

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

**891. SEMINAR IN MONETARY THEORY AND POLICY**

Contemporary developments in monetary theory and the evaluation of policy measures. 4 cr.

**892. SEMINAR IN PUBLIC FINANCE—THEORY AND POLICY**

Selected topics in contemporary theoretical and policy problems of public finance. 4 cr.

**894. 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. 4 cr.

**895 (895). INDEPENDENT STUDY****896 (896). RESEARCH WORKSHOP**

1) Finance; 2) Political Economy; 3) Labor Economics.

**899. THESIS**

Staff. 8 cr.

**999. DOCTORAL RESEARCH**

Staff.

### Education

**Chairperson:** Gerald J. Pine

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

**ASSOCIATE PROFESSORS:** Michael D. Andrew, Charles H. Ashley, Jason E. Boynton, John G. Chaltas, David D. Draves, Edward D. Durnall, David J. Hebert, Bud B. Khleif, Joseph J. Petroski, M. Daniel Smith, Deborah E. Stone, Dwight Webb

**ASSISTANT PROFESSORS:** Margaret D. Ackerman, Richard Antonak, Virginia Bereit, John Carney, Ellen Corcoran, Michael Diamonti, Ann Diller, Sidney Eder, Leo Geoffrion, Donald H. Graves, Edward J. Lawton, Jeanette Miccinati, Stephen T. Murphy

**ADJUNCT PROFESSORS:** Donald D. Durrell, Frederick Jervis

**ADJUNCT ASSOCIATE PROFESSOR:** Peter Cimboolic

**ADJUNCT ASSISTANT PROFESSOR:** John R. Cavanaugh

**GRADUATE STUDIES COORDINATOR:** David J. Hebert

### 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 or 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. Follow general admission procedures.

### Thesis or Comprehensive Examination

Candidates in the Master of Education program ordinarily will be expected to complete a research thesis, a written comprehensive examination, a set of professional statements with an oral examination, or a clinical experience. Program planned with graduate adviser to meet candidate's professional needs. No thesis or examination requirements for the Master of Arts in Teaching.

Courses are not offered in sequence; consult the time and room schedule for current offerings.

### Master's Degree Programs in Education

Six graduate programs lead to the Master of Education degree. Some programs are available to part-time admitted graduate students.

Areas of specialization include: educational administration and supervision, counseling and personnel services, early childhood education, elementary education, reading, and secondary education.

### Counseling and Personnel Services

**Program Information:** Angelo Boy, Peter Cimboolic, David Hebert, Stephen Murphy, Gerald Pine, and Dwight Webb.

Provides the graduate with the entry credentials of a professional counselor 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.

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

**Core Requirements** (20 credits): 820, Counseling Theory and Practice; 821, Psychology of Vocational Development; 822, Psychological Tests in Personnel Services; 823, Group Counseling; and 826, Practicum in Counseling.

**Electives** (12credits): Elective courses available within the counseling program are Laboratory in Counseling, and Counseling and Guidance in the Elementary School. Other graduate-level elective courses are available from any department or school in the University with offerings related to the behavioral sciences.

### Early Childhood

**Program Information:** Donald Graves, Deborah Stone  
(36 credits) A 12-month program (July through June) to prepare participants as early childhood resource specialists, with competence to assume roles as master teacher, program supervisor, curriculum consultant, in-service teacher-educator, or college level instructor. Emphasis on practicum experience coordinated with extensive course work in related academic disciplines.

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

September through June, graduate students are completely responsible for setting up and staffing early learning centers in local school districts in which they work in a co-teaching situation with another participant in the

program as well as with volunteer aids from the local community. Candidates engage in course work and seminars concurrent with the practicum experiences by returning to the campus one week per month for study (on alternate weeks for each team partner), with frequent Saturday seminars. Produce a monthly newsletter. Provide staff development workshops for local school personnel. Required independent study each semester, resulting in papers of significance to be shared at the early childhood conference.

**Additional field experiences:** visits to schools in Toronto, Canada; to Follow Through models; to Montessori Schools; as well as a three-week experience in British Infants Schools in England.

**Concluding 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, J. Boynton, Roland Kimball, and Joseph Petroski.

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 Education 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 Contemporary Educational Problems; 864, Personnel and Communication in Educational Organizations; 883, Advanced Psychology of Human Learning; 884, Advanced Human Development; 886, Philosophy of Education; 888, Sociology of Education; 895, Independent Study in Education; and from Business Administration: 713, Interpersonal and Group Dynamics; 803, Human Behavior in Organizations; Sociology 740, Culture Change; and Sociology 770, Culture, Personality, and Society.

**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, Virginia Bereit, Ellen Corcoran, Ann Diller, Edward Lawton, Carleton Menge.

(Minimum of 30 credits) Primarily for the elementary or secondary classroom teacher.

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

**Electives** (10-18 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.

**Concluding Experience:** The three options are: 1) 30 credits and the successful completion of an oral examination based on a set of theses statements; 2) A research thesis, plus 22 credits from the above; 4 credits in Education 881, Methods and Techniques of Educational Research; and 6 credits in 899, Thesis; 3) 30 credits and a written comprehensive examination, taken with the approval of one's adviser.

### Reading

**Program Information:** John Carney, Leo Geoffrion, Jeannette Miccinati

A professional preparation required of the reading specialist, concentrating on: 1) the improvement of reading abilities of all children; 2) the prevention, diagnosis, and remediation of reading difficulties.

Within the scope of the program, the following requirements will be satisfied: standards for the professional training of reading specialists recommended by the International Reading Association; and certification requirements for the reading specialist set forth by the New Hampshire State Department of Education.

The specific program will be planned, with the assistance of the student's adviser, to meet individual needs as indicated by the academic and professional background and his/her professional objectives.

**Core Curriculum** (28 credits): Education 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: Education 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.

**Concluding Requirements:** 1) Completion of 36 credits: Written comprehensive or theses with oral examination; 2) Completion of core curriculum (28 credits); 8 credits thesis, or 4 credits 881 and 6 credits thesis.

## Education

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### Master of Arts in Teaching and Master of Education Degrees for Preservice Teachers

**Program Information:** Michael Andrew, coordinator of Teacher Education.

The Department of Education offers two masters' degrees for students completing the teacher preparation program at UNH. Students may enter the teacher education program as undergraduates, thus satisfying some of the requirements for certification prior to master's level work. The programs are also open to people who have completed an undergraduate program with no work in education and to people who have finished college some time ago. Specialization is available at the primary, middle school, and high school levels. Students entering these master's degree programs will 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 part of the master's degree programs for preservice teachers. These professional requirements include Education 500, Exploring Teaching or equivalent, and each of the following education courses: 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. Minimum 12 credits (3-6 credits each). (In some cases 6 credits of internship may be allowed.)

Additional requirements for elementary school teaching are one course in elementary school reading and two courses in mathematics appropriate for elementary school teaching.

#### Master of Arts in Teaching (Elementary and Secondary)

All candidates must complete, or have completed prior to admission, a one-semester teacher aide experience or its equivalent with supportive recommendation from school staff. Education 500, Exploring Teaching, may be taken by UNH undergraduates. Other candidates will enroll in the experimental summer school program (Ed 831 or 835) which will satisfy this requirement.

##### **Core Curriculum:**

1) Twelve graduate credits outside the Department of Education (One of required math courses may be included in these 12 credits for elementary MATs.)

2) Twelve credits of Internship: Education 800 (3-6 credits) and Education 801 (3-6 credits). A six-credit internship may be approved for some MAT candidates who have had Education 831, 835, or equivalent classroom experience.

3) Graduate electives inside or outside the Department of Education (Credits in Education 700, 701, 703, and 705 may be counted as electives.)

4) Minimum of 30 credits.

**Concluding Experience:** For MAT and M.Ed. for Preservice Teachers (Elementary and Secondary).

#### Master of Education for Preservice Teachers (Elementary and Secondary)

All candidates must complete, or have completed prior to admission, a one-semester teacher aide experience or its equivalent with supportive recommendation from school staff, (Education 831 or 835) which will satisfy this requirement.

##### **Core Curriculum:**

1) Twelve graduate credits in education. Credits may be counted from Education 700, 701, 703, and 705 beyond the minimum requirements of 4 credits in each area; the required elementary reading course may be counted in the 12 hours for prospective elementary teachers. Twelve-hour specializations will be available in a number of areas including the following: reading, counseling, curriculum and instruction, and developmental disabilities.

2) Twelve credits of internship: Education 800, (3-6 credits) and Education 801 (3-6 credits). (Six credits of internship may be approved for some M.Ed. candidates who have had Education 831, 835, or equivalent classroom experience.)

3) Graduate electives inside or outside the Department of Education. (Credits in Education 700, 701, 703, and 705 may be counted as electives.)

4) Minimum total is 30 credits.

5) **Concluding Experience:** theses (professional statements and oral examination), research thesis or project. All of these options will be administered and approved by a committee of at least three faculty, chaired by the student's adviser. Theses and project options will not be taken for credit. Research thesis option requires Education 899, Thesis (6 credits), and Education 881, Research Problems in Education (4 credits), for students who have not had an advanced research course. These 10 credits may be counted toward the 12 credits of graduate specialization in education.

Students entering the MAT or M.Ed. programs with none of their professional requirements previously met will generally follow the program format listed below.

First Summer: Summer school teaching and seminars, 10 credits; 8 credits in Education 831 or Education 835; and 2 credits in Education 700. (Satisfies requirement for Education 500, Education 703, and 2 credits of Education 700.)

Academic Year: Internship (6 or 12 credits) plus varying number of credits in professional requirements and courses in area of graduate specialization.

Second Summer: Balance of degree requirements.



## Certificate of Advanced Graduate Study

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

### Counseling (CAGS)

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, Organization and Administration of Personnel Services; 828, Advanced Counseling Theory and Practice; 829, Advanced Practicum in Counseling; 830, Research in Personnel Services; and 884, Advanced Psychology of Human Development.

**Electives** (12 credits): Elective courses available within the Counselor Education Program are: Laboratory in Counseling, and Counseling and Guidance in the Elementary School.

Other graduate-level elective courses are available from the departments of education, business administration, economics, English, history, home economics, mathematics, political science, psychology, and sociology. Contact Professor Angelo Boy, Morrill Hall, for further information.

### Educational Administration and Supervision (CAGS)

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 of 12 semester hours within the administrative environment in which the person intends to function. Eight semester hours are required in instructional leadership; eight semester hours are required in management and administration. 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 Roland B. Kimball, 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. Prerequisite: Ed 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

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. Prerequisite: Ed 500 or permission of instructor, 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, micro-teaching, completion of appropriate self-instruction units, and seminars. Variable credit modules; sections listed in department prior to preregistration. Prerequisite: Ed 500 or permission of instructor, 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. Prerequisite: Ed 500 and departmental permission, except for off-campus programs. Minimum of 4 cr. required for teacher certification. Variable 1-4 cr.

## Education

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### 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.

### Courses in Developmental Disabilities

The education department offers several courses in developmental disabilities (Education 750, 751, 752, and 753).

### 750. SURVEY OF DEVELOPMENTAL DISABILITIES

A comprehensive survey of 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.

### 751. SERVICE DELIVERY SYSTEMS IN DEVELOPMENTAL DISABILITIES

A detailed exploration of service delivery system models in developmental disabilities: pre- and post-natal, 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. Prerequisite: Ed 750. 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.

### 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.

### 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). Prerequisite: permission of instructor(s). 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. Prerequisite: Ed 807 (may be taken concurrently). 4 cr.

**809. REMEDIATION OF READING DIFFICULTIES**

Procedures for remediating reading deficiencies and modifications of teaching necessary to adjust to diverse reading handicaps. Emphasis on a diagnostic teaching approach to reading remediation. Prerequisites: Ed 807 and 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 will provide opportunity for clinical analysis, micro-teaching, and evaluation. Seminars will focus on the process of reading and language and the effects of a variety of materials and methods on learning. Prerequisites: Ed 807, 808, 809 (may be taken concurrently with 811). 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. Prerequisites: Ed 807, 808, 809 (may be taken concurrently with 812). 4 cr.

**813. FIELD PRACTICUM**

Field-based experience focusing on roles of the reading specialist in the school setting. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 4 cr.

**820. COUNSELING THEORY AND PRACTICE**

The basic approaches to counseling are examined. Consideration is given to their theoretical foundations, process components, goals, and outcomes. 4 cr.

**821. PSYCHOLOGY OF VOCATIONAL DEVELOPMENT**

An investigation of the psychological and informational factors which influence occupational decisions and progress. 4 cr.

**822. ASSESSMENT IN COUNSELING**

An analysis of 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 are reviewed. Assessment is viewed from the perspective of its use in the counseling process as well as its use in accountability. 4 cr.

**823. GROUP COUNSELING**

An examination of the 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. Prerequisite: Ed 820. 4 cr.

## Education

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### 824. COUNSELING AND GUIDANCE IN THE ELEMENTARY SCHOOL

Principles and procedures of counseling and personnel services for meeting the developmental needs of elementary school pupils. 4 cr.

### 825. LABORATORY IN COUNSELING

Introductory field experience in counseling with supervision and seminar to integrate theory and practice. Prerequisite: Ed 820. 4 cr.

### 826. PRACTICUM IN COUNSELING

Supervised experiences in counseling with actual clients in the usual organizational settings. Open only to M.Ed. candidates in counselor education. Prerequisite: permission of instructor. 4 cr.

### 827. ORGANIZATION AND ADMINISTRATION OF PERSONNEL SERVICES

Investigation of organizational patterns and administrative procedures which influence the effectiveness of personnel services programs. Emphasis on elements of productive supervisory and staff relationships. Prerequisite: permission of instructor. 4 cr.

### 828. ADVANCED COUNSELING THEORY AND PRACTICE

Detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prerequisite: permission of instructor. 4 cr.

### 829. ADVANCED PRACTICUM IN COUNSELING

Supervised application of advanced counseling theory and practice in actual counseling situations. Samplings of counseling practices will be analyzed and evaluated. Open only to CAGS candidates in counselor education. Prerequisite: Ed 828 and permission of instructor. 4 cr.

### 830. RESEARCH IN PERSONNEL SERVICES

A study of research design and methodology in personnel services. Prerequisite: permission of instructor. 4 cr.

### 831. SEMINAR AND PRACTICUM IN ELEMENTARY SCHOOL TEACHING

Supervised Practicum: Exploratory summer practicum in a local summer elementary school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a pre-practicum 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.) Prerequisite: admission to the Master of Arts in Teaching Program or Master of Education Program for Preservice Teachers. 8 cr.

### 835. SEMINAR AND PRACTICUM IN SECONDARY SCHOOL TEACHING

Supervised Practicum: An exploratory summer practicum in a local summer high school to examine teaching as a career and to prepare for the internship in the fall. Summer includes: 1) a pre-practicum workshop focusing on interpersonal skill development; 2) a pre-practicum curriculum and instruction laboratory; 3) a six-week practicum in which candidates, with the help of the staff, serve as the teaching staff in a local summer school; 4) seminars in curriculum and instruction. Opportunities for teaching on elementary level are available for candidates who wish to determine better what level of teaching they prefer. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching Program or Master of Education Program for Preservice Teachers. 8 cr.

### 838. SOCIOLOGY OF EDUCATION: SOCIAL ORGANIZATION OF SCHOOLS AND COMMUNITY

Schools are viewed in their socio-cultural context. Work is centered on a number of field studies of urban and suburban communities. Among the topics discussed: (a) comparative institutional analysis—what is church-like; hospital-like, factory-like, and prison-like about the school; (b) relations and perspectives of functionaries and clients in “culturally deprived” and “culturally endowed” settings; and (c) teaching as an emergent profession. 4 cr.

### 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. Prerequisite: 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. Prerequisite: Ed 841 and 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. Prerequisite: 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. Prerequisite: Ed 841, 843, 846, and 848. 4 cr.

**853. SEMINAR IN CURRICULUM STUDY**

Techniques and procedures of curriculum development and strategies for curriculum change in the public school. Prerequisite: teaching experience. 4 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. Prerequisite: teaching experience. 4 cr.

**861. PUBLIC SCHOOL ADMINISTRATION**

Introductory course examining major issues in policy-making, school management, personnel, public relations, finance, and research in school administration. Prerequisite: 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. Experience in handling practical school finance problems will be part of the project work. Prerequisite: Ed 861. 4 cr.

**863. SEMINAR IN EDUCATIONAL ADMINISTRATION**

Cases and concepts in educational administration. Prerequisite: Ed 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. Prerequisite: 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. Prerequisites: Ed 853, 865, and permission of the instructor. 4 cr.

**867. LEGAL ASPECTS OF SCHOOL ADMINISTRATION**

Investigation of 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. Prerequisite: Ed 861 and 863. 4 cr.

**869. PRACTICUM IN EDUCATIONAL ADMINISTRATION**

Supervised practical experience in dealing with problems in educational administration. Prerequisite: Ed 863. 4 cr.

**870. THE CHANGE PROCESS IN EDUCATION**

Role of change agent and the change process in education as related to school personnel will be stressed. Structural characteristics of the school culture will be examined. Change theory and systems analysis techniques will be presented. Students will be required to apply some of the theories in an institutional setting. 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 significant administrative problem at the intern-site. Supervision by University faculty. Permission of graduate adviser is required. 6 cr.

## Electrical Engineering

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### 881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH

Quantitative methods employed in the investigation of educational problems. Permission of instructor. 4 cr.

### 883. ADVANCED PSYCHOLOGY OF HUMAN LEARNING

Classroom learning situations: experimental research; application of major theories of learning. Prerequisite: Ed 701. 4 cr.

### 884. ADVANCED HUMAN DEVELOPMENT

A study of selected principles and skills mankind must consider in the attempt to maximize individual, social, and educational potential, with special emphasis on personal implementation. Prerequisites: Ed 701 or Psych 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.

### 888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE

Two cultures treated as unit; culture change discussed. Current issues: poverty, school desegregation, schooling of geographically mobile children; social mobility and abundance, rise of counseling and healing trades, teachers' quest for professionalism, education of "culturally endowed" children. 4 cr.

### 889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOL AND SOCIETY

Ethnic stratification and inter-group processes in and outside school. Public schooling of disadvantaged groups such as black, Indian, white Appalachian, and Mexican Americans. Caste and class relations within social contexts. Socio-anthropological perspective. 4 cr.

### 895. INDEPENDENT STUDY IN EDUCATION

Opportunity for intensive investigation of a special problem or issue in the field of education. Permission of instructor is required. 2-4 credits per semester. May be repeated to a maximum of 8 cr.

### 899. THESIS

Prerequisite: permission of the department. 8 cr.

## Electrical Engineering

**Chairperson:** Joseph B. Murdoch

**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:** M.R. Cannon, P.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, and energy conversion, with appropriate laboratory experiences.

A minimum of 30 credits is required for the Master of Science degree in Electrical Engineering. All students are required to complete two basic courses, Electrical Engineering 801 and 811, at the beginning of their program or furnish evidence of equivalent preparation. Students are further required to demonstrate the ability to do independent and creative work by taking either Electrical Engineering 899 or 891-892. With the consent of the Graduate Committee, a student who has satisfied this requirement through industrial experience may substitute approved course work.

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. Electrical Engineering 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 Engineering Department considers the development of professional communication skills in the form of a teaching assignment as a basic component of a graduate education. Every master's candidate is required to satisfactorily complete one year of EE 800 seminar; participation will include presentations as needed to satisfy the teaching requirement.

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 above areas. For details refer to the section entitled Engineering Ph.D. Program on page 72.

Permission of instructor is required for enrollment in all electrical engineering graduate courses.

## Areas of Specialization

Courses may be selected to provide a specialization in the following program areas, both for the M.S. degree or for the Ph.D. program.

### 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.

### 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 bio-electronics. 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.

### Fields and Waves

Radiation of electromagnetic waves in a plasma, electromagnetic and acoustic probing of media with pulses, propagation studies in weakly turbulent media such as sea, the atmosphere, and plasmas.

### Geophysical Sensing

Ground based electromagnetic techniques for probing of upper atmosphere and the ionosphere; electromagnetic pulse techniques for probing of ice, snow, and other material media. Acoustic probing of bottom and subbottom sediment in water.

### Network Theory

Active network synthesis techniques, application of network theory to societal systems, sensitivity studies of passive and active network synthesis methods, digital adaptive equalizers, and analysis and design of linear phase and constant delay networks.

### 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 mid-ocean 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.

### Solid State Electronics

Design of active devices and circuits, and the theory and technology of silicon monolithic devices and circuits.

## 620. ELECTRONICS AND INSTRUMENTATION

For non-engineering or non-physics 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. Prerequisite: junior standing. 3 rec/1 lab/4 cr.

## 711. DIGITAL SYSTEMS

Extension of EE 543 to advanced switching theory techniques (design of unlocked sequential circuits, minimization of multiple output circuits, etc.) and digital design tools (L.S.I., multiplexing, etc.). Applications. Prerequisite: EE 543 or permission of instructor. 3 rec/1 lab/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. Prerequisite: EE 543 or permission of instructor. 3 rec/1 lab/4 cr.

## Electrical Engineering

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### 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. Prerequisite: EE 543 and programming experience, or permission of instructor. 3 rec/1 lab/4 cr.

### 727. POWER SYSTEMS

Modeling and planning of electric power transmission systems. Prerequisite: EE 654. 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 ME 741.) 4 cr.

### 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. Prerequisite: Phys 408, Math 527. 3 rec/1 lab/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. Prerequisite: EE 608 and permission of instructor. 3 rec/1 lab/4 cr.

### 758. COMMUNICATION SYSTEMS

Design of high frequency communication systems. RF amplification, modulators for AM and FM systems, receiving techniques, antennas, free space propagation, propagation characteristics of the ionosphere. Prerequisite: EE 604, 757 or equivalent. 3 rec/1 lab/4 cr.

### 762. ILLUMINATION

Radiation; color and spectra; physics of light production; sources of ultra-violet, 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

The 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 fresh-water 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. Prerequisite: 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. Prerequisite: permission of instructor. 3 rec/1 lab/4 cr.

### 783. BIOMEDICAL ENGINEERING

Engineering applied to cardiovascular, renal, gastrointestinal, sensory, reproductive, and other organ systems. Topics will include design and utilization of diagnostic, monitoring, and prosthetic techniques and devices. A design-oriented project will be required. Prerequisite: A human physiology course (may be taken concurrently). 3 rec/1 lab/4 cr.

### 784. BIOELECTRONICS

Survey of engineering principles applied to medicine including physiological measurements, biotelemetry, modeling and simulation, electrical safety, biosignal processing, and computer applications. Prerequisite: permission of instructor. 3 rec/1 lab/4 cr.

### (785). UNDERWATER ACOUSTICS

Vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small and large signal considerations. Prerequisite: permission of instructor. 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. Prerequisite: senior or graduate status in technology. 4 cr.

### 796 (796). SPECIAL TOPICS IN ELECTRICAL ENGINEERING

New or specialized courses and/or independent study. Prerequisite: permission of instructor. 2 or 4 cr.



## 800 (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 of electrical and electronics engineers. Participants may prepare and give presentations to satisfy teaching practice requirements. 0 cr. NLG.

## 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. Prerequisite: EE 603 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. Prerequisite: EE 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. Prerequisite: EE 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. Topics will include oscillators, phase-locked systems, low noise techniques, etc. 3 cr.

## 817. SPECIAL TOPICS IN NETWORK THEORY

Study of advanced topics in network theory of interest to students and staff, taken from such areas as nonlinear networks, distributed networks, time domain synthesis, computer aided design, time varying networks, n ports, linear graph theory. Prerequisite: EE 812. 3 cr.

## 831. SOLID STATE ELECTRONICS

A study of topics in solid state electronics including semiconductor physics, transport phenomena, recombination, pn junctions, bipolar and field effect transistors, photoconductivity, and selected applications of semiconductor technology. Prerequisite: EE 609 or equivalent. 3 lec/arr. lab/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. Prerequisite: EE 839. 3 cr.

## 841. DIGITAL SIGNAL PROCESSING

An introduction to the theory and practice of digital signal processing. Topics covered include the 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

The 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 ME 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. Prerequisite: EE 851. 4 cr. (Also offered as ME 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. Prerequisite: EE 782. 3 cr. (Also offered as ME 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. Prerequisite: EE 851. 3 cr. (Also offered as ME 852.)

## Engineering Ph.D. Program

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### 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. Prerequisite: EE 711. 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. Prerequisite: Knowledge of computer terminal operation, BASIC language; Math 636 and 645 or equivalents. 3 rec/3 cr.

### 875. ARTIFICIAL INTELLIGENCE

Alternative approaches to machine intelligence, state-space, heuristic goal searching, game trees, game position generation, evaluation and back-up procedures (depth first, mini-max, alpha-beta), pruning, the resolution principle, elementary theory of computability. Individual project (computer program) required. Prerequisites: Knowledge of computer operation, BASIC language. 3 rec/3 cr.

### 880. AUTOMATA THEORY

Mathematic linguistics, grammar re-write rules, context-dependent, context-free and regular languages, finite state machines and regular expression recognizers, infinite state machines, Turing machines, unsolvable problems, linear-bounded and pushdown automata, cellular and reproducing automata Garden-of-Eden configurations in tessellated spaces. Prerequisites: Knowledge of computer terminal operation and BASIC. 3 rec/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. per semester.

### 899. MASTER'S THESIS

6 cr.

## Engineering Ph.D. Program

**PROFESSORS:** Fletcher A. Blanchard, Ronald R. Clark, Robert W. Corell, Stephen L. Fink, Albert D. Frost, Shan S. Kuo, Joseph B. Murdoch, Godfrey H. Savage, Charles K. Taft, Robin D. Willits, Alden L. Winn, Asim Yildiz

**ASSOCIATE PROFESSORS:** Paul L. Bishop, Stephen S.T. Fan, Glen C. Gerhard, Filson H. Glanz, R. Stephen Jenks, Louis H. Klotz, David E. Limbert, Donald W. Melvin, William Mosberg, John L. Pokoski, Kondagunta Sivaprasad, Linda A. Sprague, Kerwin C. Stotz, Russell L. Valentine, Tung-Ming Wang, John A. Wilson

**ASSISTANT PROFESSORS:** Wendell S. Brown, Michael Cannon, Barbaros Celikkol, Virendra K. Mathur, Dennis J. O'Brien, Gail D. Ulrich, Charles E. Wyman

**ENGINEERING Ph.D. COMMITTEE:** Asim Yildiz, Ronald R. Clark, 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 increasingly indistinct. The particular advantage of the non-departmental program structure is that improved communication and cooperation develop among faculty and students of the different disciplines and results 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, fluidic systems, nonlinear decoupling control, societal systems, facility systems, and social and business systems.

**Signal Processing:** Ronald R. Clark, 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: network synthesis, biomedical instrumentation, acoustics, geophysical sensing, digital signal processing, systems modeling, digital systems, nonlinear interacting system-control, and fluidics.

**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 equilibrium 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 micro-mechanics 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, ocean-cable 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, polymer processing, vortex flow, coal gasification, 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 he/she has sufficient background in the area in which he/she proposes to specialize.

Following the entrance of a student 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 preparation 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 course work, will administer the qualifying examination. This committee is also responsible for administering the language examination and other 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 by the dean of the Graduate School upon the recommendation of the chairperson of the student's area. The Doctoral Committee shall conduct an annual review of the student's progress, supervise and approve the doctoral dissertation, and administer the final examination.

To obtain a Ph.D. degree in engineering, a student must meet all of the general requirements as stated under Regulations of the Graduate School. A student will normally be required to demonstrate the ability to read scientific and technical literature in one approved foreign language; however, in specific cases a student's Guidance Committee may require a second language or, in lieu of a language, a demonstrated facility in one or more special research techniques such as digital or analog computation. The student, depending on his/her educational objectives, may also be required by the Guidance Committee to undertake a classroom teaching experience. To complete the Ph.D. degree in Engineering a student will normally be expected to take course work equivalent to two full-time academic years beyond the baccalaureate and to complete a dissertation which will require at least one full-time year of study and original research. Specific course requirements have been established for each area of specialization. All these requirements should normally be completed by the end of the second year of full-time graduate study, and must be completed before the student can be advanced to candidacy.

## English

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### 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 course work 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 the Course Descriptions section of this catalog for specific course offerings and descriptions.

### 999. DOCTORAL RESEARCH

## English

**Chairperson:** Donald M. Murray

**PROFESSORS:** Robert Hapgood, Edmund G. Miller, Donald M. Murray, Philip L. Nicoloff, John C. Richardson, John A. Yount, Thomas A. Williams

**ASSOCIATE PROFESSORS:** S. Anthony Caldwell, Thomas A. Carnicelli, Carl Dawson, Michael DePorte, Karl Diller, Lewis C. Goffe, Jean E. Kennard, Gary H. Lindberg, Terence P. Logan, Charles Simic, Mark R. Smith, Theodore Weesner

**ASSISTANT PROFESSORS:** Earl Briden, Elizabeth H. Hageman, Annette Kolodny, Andrew H. Merton, Hugh M. Potter III, Susan M. Schibanoff, 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.

#### 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, non-fiction, 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 speciality, 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, non-fiction articles, a non-fiction 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. Specialities include applied linguistics and the teaching of English as a second language as well as the traditional sub-fields 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 the high school teacher. No foreign language is required. The student must take eight courses in English, numbered above 700, 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 course work 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 ninety-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.

**701-702/801-802. ADVANCED WRITING OF FICTION**

Prerequisite: Engl 625-626 or its equivalent and permission of instructor. May be repeated for credit with the approval of the department chairperson. 4 cr.

**703-704/803-804. ADVANCED NON-FICTION WRITING**

Prerequisite: permission of instructor. May be repeated for credit with the approval of the department chairperson. 4 cr.

**705-706/805-806. ADVANCED WRITING OF POETRY**

Prerequisite: Engl 627-628 or its equivalent and permission of instructor. May be repeated for credit with the approval of the department chairperson. 4 cr.

**707. FORM AND THEORY OF FICTION**

The problems, aims, and structures of fiction from the point of view of the writer. 4 cr.

**708. FORM AND THEORY OF NON-FICTION**

Contemporary non-fiction from the point of view of the writer, emphasizing the choices the writer faced in the process of research and writing. 4 cr.

**709. 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.

**710. CRITICAL ANALYSIS OF FICTION**

A non-historical approach to individual short stories and novels. 4 cr.

**711. CRITICAL ANALYSIS OF POETRY AND DRAMA**

A non-historical approach to individual poems and plays. 4 cr.

**712. CRITICAL ANALYSIS OF EXPOSITION**

For the English Teaching major; students analyze essays and write non-fiction 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.

## English

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### 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. Prerequisite: Engl 621 or its equivalent and permission of instructor. Variable, max. 16 cr.

### 742/842. PURITANISM AND THE ENLIGHTENMENT IN AMERICA

American literature and thought from the Colonial beginnings through the early republic. 4 cr.

### 743/843. AMERICAN TRANSCENDENTALISTS

Emerson, Thoreau, and other transcendentalists. 4 cr.

### 744/844. AMERICAN FICTION TO THE CIVIL WAR

Cooper, Poe, Hawthorne, Melville, and others. 4 cr.

### 745/845. AMERICAN POETRY OF THE 19th CENTURY

Bryant, Poe, Emerson, Whitman, Dickinson and others. 4 cr.

### 746. AMERICAN LITERATURE, 1865-1915

Fiction, poetry, and prose in the era of industrialism, realism, naturalism, big money, and the minute concern with daily life. Individual works in relation to the cultural background. Mark Twain, Henry James, William James, Dickinson, Crane, Chopin, Dreiser, Wharton, and others. 4 cr.

### 747,748/847,848. AMERICAN FICTION AND DRAMA OF THE 20th CENTURY

Major writers since World War II. Selections vary from year to year. 4 cr.

### 749/849. AMERICAN POETRY OF THE 20th CENTURY

Robinson, Frost, Stevens, Pound, Eliot, Jeffers, Hart Crane, Robert Lowell, and others. 4 cr.

### 750. MAJOR AMERICAN AUTHORS

Works of two or three American writers; may include: Melville and Faulkner, Hawthorne and James, Frost and Stevens. See department for current offering. 4 cr.

### 751. 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. Prerequisite: 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. CONTINENTAL BACKGROUNDS OF THE ENGLISH RENAISSANCE

Major philosophers, artists, and writers of the continental Renaissance (in translation); Petrarch, Ficino, Pico, Vives, Valla, Castiglione, Machiavelli, Luther, Calvin, Rabelais, Montaigne, Cervantes, Erasmus, and Thomas More, as representative of the early English Renaissance. 4 cr.

### 764. 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. LITERATURE OF THE RESTORATION AND EIGHTEENTH CENTURY

Texts studied closely; attention to how texts reflect the central intellectual problems of their age. 767: Dryden, Rochester, Restoration 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. 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. ENGLISH DRAMA TO 1800**

Development from the Middle Ages through the 18th century, emphasizing 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. 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 performances 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 Bronte, Charlotte Bronte, Trollope, George Eliot, Hardy, and Conrad. 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. Prerequisite: a basic linguistics course or permission of the instructor. 4 cr.

**794/894. SYNTAX AND SEMANTIC THEORY**

Relation between grammar and meaning; special reference to poetic language. Prerequisite: Engl 718 and 752 or permission of the instructor. 4 cr.

**795,796. INDEPENDENT STUDY**

Individual guided study in special topics. Open to MST candidates. Open under special circumstances to MA candidates upon petition to the departmental graduate committee. Graduate faculty. 1-4 cr.

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

1) Old English Literature, 2) Medieval Literature, 3) The Renaissance, 4) The 17th Century, 5) The 18th Century, 6) The English Romantic Period, 7) The Victorian Period, 8) The 20th Century, 9) The Drama, 10) The Novel, 11) Poetry, 12) Non-Fiction, 13) American Literature, 14) A Literary Problem. The precise topics and methods of each section will vary. Barring duplication of subject, may be repeated for credit. For details, see the course descriptions available in the English department. 4 cr.

**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. Permission of instructor required. 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.
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

**Chairperson:** G. Thomas Fisher

**PROFESSOR:** Robert L. Blickle

**ASSOCIATE PROFESSORS:** G. Thomas Fisher, R. Marcel Reeves

**ASSISTANT PROFESSOR:** James S. Bowman

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. Mr. Blickle. 2 lec/1 lab/4 cr.

### 707,708. ADVANCED ENTOMOLOGY

R1. Taxonomy; R2. Morphology; R3. Aquatic Insects; R4. Insect Physiology. Required of Entomology majors; open to others by permission of instructor. Mr. Blickle, Staff. 2 lec/1 lab/4 cr.

### 709,710. ADVANCED ECONOMIC ENTOMOLOGY

R1. Agricultural Entomology; R2. Biological Control of Insects; R3. Chemical Control of Insects; R4. Regulatory Entomology; R5. Structural Pest Control. Required of Entomology majors; open to others by permission of instructor. Hours arr. Mr. Fisher, Staff. 2 or 4 cr.

### 801,802. GRADUATE ENTOMOLOGY

Concentrated studies in insect biology, systematics, and biological control or chemical control of insects. Mr. Blickle, Mr. Reeves, and staff. Subject matter, hours, and credits to be arranged.



**899 (899). GRADUATE ENTOMOLOGY—MASTER'S THESIS**

Mr. Blickle, Mr. Fisher, Mr. Reeves, and staff. Hours and credits to be arranged. 6-10 cr.

## French

**Chairperson:** Grover E. Marshall

**PROFESSOR:** Louis J. Hudon

**ASSOCIATE PROFESSOR:** Jack R. Vrooman

**ASSISTANT PROFESSORS:** Rose Antosiewicz, Lydia Crowson, Samuel Gatteño, Grover E. Marshall

The Department of French and Italian offers courses leading to the degree of Master of Science for Teachers in French. To be admitted to graduate study for this degree, the applicant must meet requirements as specified on page 13. The primary intent of the program is to strengthen the linguistic and literary knowledge and skill of secondary-school teachers of French. Students in this program must complete 10 courses. Eight must be in French, six from French courses numbered 800 or above. Two courses may be taken in related departments. For the convenience of in-service teachers, two courses leading to this degree are offered in the late afternoon hours each semester. Courses are also offered in the Summer Session according to demand. The candidate for this degree must pass a departmental oral and written examination six weeks before the degree is to be granted.

The department is also prepared to offer work leading to the degree of Master of Arts in French. Admission to this program is suspended until there is again sufficient interest in it. Those interested in the program are urged to express their interest to the dean of the Graduate School and to the chairperson of the French department. Applicants must have completed an undergraduate major in French. Requirements for the Master of Arts degree are similar to those for the MST in French except that the master's thesis replaces two French courses and the departmental examination.

All applicants for graduate study in French must submit their scores in the Graduate Record Examination, both the Aptitude Test and the Advanced Test in French.

All French courses are conducted in French. Except for 899, the courses listed below are also available at the 700 level.

## French

**791. METHODS OF FOREIGN LANGUAGE TEACHING—FRENCH**

Interdepartmental course. Objectives, methods, and techniques in teaching Spanish, French, German, and Latin from elementary through college. Discussion, demonstration, preparation of instructional materials, micro-teaching of the language skills. Prerequisite: permission of instructor. No credit toward a French major. 4 cr.

**(841). FRENCH LITERATURE OF THE MIDDLE AGES**

Epic, lyric poetry, and romance. (Offered irregularly.) 3 cr.

**(842). FRENCH LITERATURE OF THE RENAISSANCE**

(Offered irregularly.) 3 cr.

**859-860. FRENCH LITERATURE OF THE 17th CENTURY**

3 cr. (Alternate years; offered 1977-78.)

**861-862. 18th CENTURY FRENCH LITERATURE AND THOUGHT**

3 cr. (Alternate years; offered 1976-77.)

**867-868. 19th CENTURY FRENCH LITERATURE**

Romanticism and Realism. 3 cr. (Alternate years; offered 1977-78.)

**(870). INTRODUCTION TO MODERN FRENCH POETRY**

Baudelaire to the present. 3 cr. (Offered irregularly.)

**881-882. CONTEMPORARY FRENCH NOVEL AND THEATER**

From 1890 to the present. 3 cr. (Alternate years; offered 1976-77.)

**888. A SEMINAR IN FRENCH LITERATURE**

A study of French authors chosen by the instructor. 3 cr.

**890. ADVANCED LANGUAGE AND STYLE**

Translation of literary texts, intensive study of principal techniques of style, explication de textes. 3 cr.

**895,896. SPECIAL STUDIES IN FRENCH LANGUAGE AND LITERATURE**

Individual guided study of the work of a major author, a genre, or specific topics in literature. Training in bibliography and organization of material. Prerequisite: permission of the department chairperson. Variable cr.

**899. MASTER'S THESIS**

1-6 cr.

## Italian

**795,796. INDEPENDENT STUDY IN ITALIAN LANGUAGE AND LITERATURE**

Individual guided study in special topics. Prerequisite: permission of the department chairperson. 2 or 4 cr.

### Genetics Program

**Chairperson:** Gerald M. Dunn

**PROFESSORS:** James P. Barrett, Walter M. Collins, Gerald M. Dunn, D. MacDonald Green, Harold W. Hocker, Jr., Lincoln C. Peirce, Owen M. Rogers

**ADJUNCT PROFESSOR:** Ernest J. Schreiner

**ASSOCIATE PROFESSORS:** Thomas P. Fairchild, Frank K. Hoornbeek, Yun Tzu Kiang, J. Brent Loy, Edward R. Pierce, Willard E. Urban, Jr.

**ASSISTANT PROFESSORS:** W.T. Adams, Robert M. Zsigray

**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, Genetics 705; 2) Molecular Genetics—Biochemical Genetics, Genetics 770; Microbial Genetics, Microbiology 804; Developmental Genetics, Plant Science 832; 3) Classical Genetics—Plant Genetics, Plant Science 851 Cytogenetics, Plant Science 853; Quantitative Genetics, Animal Science 811; Human Genetics, Zoology 707. 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. Prerequisite: Zoo or PS 604 and FR 528, or equivalents, or permission of instructor. Mr. Kiang. 4 lec/4 cr. (Alternate years, offered 1978-79.)

#### 706. GENETICS LABORATORY

Experiments and demonstrations in classical, developmental, and population genetics and cytogenetics, utilizing a wide range of organisms and techniques. Genetics faculty. Prerequisite or concurrent: Zoo 604, Principles of Genetics, or equivalent, and permission of instructor. 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. Mr. Kiang. Prerequisite: Zoo 604, PLS 604, or equivalent, or permission of instructor. 4 lec/4 cr. (Alternate years; offered 1977-78.)

#### 770. BIOCHEMICAL GENETICS

The biochemical mechanism of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochem 751 or permission of instructor. 3 lec/1 lab/4 cr. (Alternate years, offered 1977-78.)

**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 non-factorial designs, fractional replication and confounding, and cross-over designs. Mr. Urban. Prerequisite: FR 711; and Math 410, Digital Computer Systems; or permission of instructor. 3 cr. (Alternate years; offered 1977-78.)

**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. Prerequisite: FR 711 and Math 410. Digital Computer Systems; or permission of instructor. 3 cr. (Alternate years; offered 1978-79.)

**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. Prerequisite: permission of staff concerned. 2-4 cr.

**(898) 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 the Cooperating Departments

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. Prerequisite: 4 cr. of genetics or permission of instructor. Mr. Collins. 3 lec/1 lab/4 cr.

**812. QUANTITATIVE GENETICS AND SELECTION**

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, and correlated characters. Mr. Collins. Prerequisite: one course each in genetics and statistics. 3 cr. (Alternate years; offered 1977-78.)

### Forest 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. Prerequisite: INER 528 or equivalent. Mr. Barrett. 4 cr.

**720. FOREST REGENERATION AND TREE IMPROVEMENT**

Improvement of forest stands through control of seed source and tree breeding. Artificial regeneration, seed production, variation in natural populations, selection of desired characters, and breeding methods. Prerequisite: FR 527 and 629, or permission of instructor. Mr. Adams. 2 lec/1 lab/3 cr. (Alternate years; offered 1977-78.)

### Microbiology

**804. MICROBIAL GENETICS**

Expression, regulation, recombination, and transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Prerequisite: Micro 503 and permission of instructor. 2 lec/1 lab/4 cr. (Alternate years; offered 1978-79.)

### 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. Prerequisite: introductory genetics and physiology. 3 lec/1 lab/4 cr. (Alternate years; offered 1977-78.)

**773. METHODS AND THEORY OF PLANT BREEDING**

Plant breeding systems for qualitative and quantitative plant improvement. Prerequisite: PS or Zoo 604, FR 528; or permission of instructor. Mr. Peirce. 3 lec/3 cr. (Alternate years; offered 1978-79.)

**851. PLANT GENETICS**

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 cr. (Alternate years; offered 1977-78.)

## German

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### 853. CYTOGENETICS

Chromosome structure. Behavior of aberrant forms. Effect of radiation on chromosomes. Laboratory techniques in cytogenetic analysis. Prerequisites: Genetics, Cytology, Mr. Rogers. 2 lec/1 lab/3 cr. (Alternate years; offered 1978-79.)

## Zoology

### (707). HUMAN GENETICS

Inheritance patterns, gene and chromosome mutation rates and effects, linkage, and gene frequency. Prerequisite: Zoo 604 or equivalent or permission of instructor. 4 cr.

## German

**Chairperson:** Michael J. Rosenbush

**ASSOCIATE PROFESSORS:** Marron C. Fort, Helmut F. Pfanner, Michael J. Rosenbush

**ASSISTANT PROFESSORS:** Roger S. Brown, James L. Sherman

**DIRECTOR OF STUDIES ABROAD:** Karl S.N. Arndt

The Department of German offers a program of graduate study in German leading to the degree of Master of Arts.

The graduate program is offered only through the German Summer School of the Atlantic, which represents a new approach in educating teachers of German in American secondary schools and universities and combines the resources of UNH with the experience of the Goethe Institute of Munich, Germany. The program is designed to meet such needs as: conversational mastery, teaching skills, and transfer credit for students with varied backgrounds in advanced German. The courses are offered only in the summer and are selected to provide a well-balanced program for the degree in a minimum of four summers.

This program provides the opportunity to master spoken and written German in a concentrated form which cannot be offered by most foreign universities.

To be admitted to graduate study, a student must have completed an undergraduate major in German. The Advanced Test in German of the Graduate Record Examination—unless taken earlier—is to be taken before the end of graduate studies. Students who have not had German 781, History and Development of the German Language, or its equivalent, must take it before completing graduate studies. It is required that students have a very good command of spoken and written German.

To satisfy the requirements for the degree of Master of Arts, the student must: 1) successfully complete ten full courses including two seminars, or 2) complete eight courses successfully and write a master's thesis. The candi-

date must also pass the departmental comprehensive examination based upon the master's reading list.

A student may take up to 18 credits of graduate study at the University of Salzburg. The student should consult with the director of studies abroad.

Courses numbered 700-799 are for graduates and advanced undergraduates.

Courses numbered 800-899 are open only to graduate students. In rare instances, an undergraduate may be admitted with the permission of the instructor and the department chairperson. Graduate students 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 High 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; Brecht, Döblin, Zuckmayer, Musil, Broch, Graf, and others. 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.

**795,796. SPECIAL STUDIES IN GERMANIC LANGUAGES, LITERATURE, AND CULTURE**

Topics to be arranged. Examples of *typical* courses: Bibliography and Methodology, Influence of German Philosophy on Literature, Phonology, The Structure of Modern German, Renaissance, Baroque, "Biedermeier," Büchner. Offered summer only. Normally 2 credits equal half-course. Variable to 4 cr.

**878. CONTEMPORARY GERMAN LITERATURE**

Literary trends since 1948 in the two German states, Austria, and Switzerland; Böll, Johnson, Celan, Frisch, Dürrenmatt, Weiss. Offered summer only. 3 cr.

**885-886. GRADUATE STUDIES ABROAD**

Program of studies at University of Salzburg, Austria, for students who have been admitted to the Graduate School. Students should consult with the director of the Studies Abroad program.

**888. SEMINAR**

An intensive study of a literary or cultural topic. Offered summer only. 3 cr.

**895. SPECIAL STUDIES IN GERMAN LANGUAGE AND LITERATURE**

Independent investigation of a range of subjects. Barring duplication of material, course may be repeated for credit. Offered summer only. 3 cr.

**899. MASTER'S THESIS**

6 cr.

**History**

**Chairperson:** Robert M. Mennel.

**PROFESSORS:** Charles E. Clark, Hans Heilbronner, Charles A. Jellison, William R. Jones, David F. Long, Darrett B. Rutman, Cecil J. Schneer, Douglas L. Wheeler, Donald J. Wilcox.

**ASSOCIATE PROFESSORS:** Robert C. Gilmore, Marion E. James, Allen B. Linden, Frank D. McCann, Robert M. Mennel, Marc L. Schwarz, John O. Voll.

**ASSISTANT PROFESSOR:** Judith A. Silver.

**DIRECTOR OF GRADUATE STUDIES:** Donald J. Wilcox.

**Admission**

The department usually requires completion on 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 course work 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 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.

# History

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## 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 option 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 option may prepare a student for entrance to the Ph.D. program. Option B is particularly recommended for practicing teachers.

**Option 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.

**Option 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 course work, or during the final semester of course work, 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 Option 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 Option A thesis readings and Option 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 course work; 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 his 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.

N.B. No student will be considered to be intending to pursue a Ph.D. program who is not in the process of satisfying these requirements. Only students who are intending to pursue the Ph.D. are considered for graduate assistantships.

3) Two languages or one language and a special research technique, whichever is deemed most relevant to the area of research.

4) The entirety of American history, with accent upon either of the subfields of Early or Modern America, and two subfields outside of American history.

5) A cognate field outside of history entirely or a subfield of non-Western history.

The student's preparation for the qualifying examinations will be guided by representatives of each subfield or cognate field in his 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 course work.

Normally there will be eight steps in attaining the degree. The student is expected to be registered in the University for all regular academic semesters during his progress:

1) Satisfaction of historiography, historical methods and research seminar requirements.

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.

## 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.

## Courses

### 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. 19th CENTURY AMERICA

Domestic and international factors in the development of the American Republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. 4 cr.

### 715,716. 20th CENTURY AMERICA

United States history since 1896, from the triumph of industrialism on the national scene to the emergence of America as a world power in the nuclear age. Political, economic, and diplomatic developments. 4 cr.

### 719,720. THE FOREIGN RELATIONS OF THE UNITED STATES

Primarily the history of American diplomacy, with attention given to the non-diplomatic aspects. First semester: American Revolution to 1890; Second: 1890 to date. 4 cr.

### 721,722. HISTORY OF AMERICAN THOUGHT

Significant American thinkers considered in their social context. First semester: 1600 to 1860. Second semester: 1860 to the present. 4 cr. (Alternate years; offered 1976-77.)

## History

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### 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. His 531-532 is 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. His 531-532 is 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 will be given considerable attention. 4 cr.

### 747. 18th CENTURY FRANCE: THE OLD REGIME

How France changed from a society in which bonds were local to one in which noble and peasant alike identified with the state. 4 cr.

### 748. 19th CENTURY EUROPE: SOCIAL UPHEAVAL AND POLITICAL CHANGE

Tensions between social classes and their impact on protest and revolution. 4 cr.

### 751,752. EUROPEAN INTELLECTUAL HISTORY

The European intellectual tradition from the Greek philosophers to the end of World War II. How basic ideas have developed out of previous modes of thought in response to new challenges. 4 cr. (Alternate years; offered 1976-77.)

### 756. 20th CENTURY EUROPE

World War I, European totalitarianisms, World War II, the loss of European primacy, and the search for a new Europe. 4 cr.

### (759). HISTORY OF MODERN SPAIN AND PORTUGAL

The 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

The 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

The costs of modernization; Leninist and Stalinist revolutions; Soviet consolidation. 4 cr.

### 767,768. HISTORY OF GERMANY

From the Reformation to the Third Reich and the presently divided Germany. Emphasis on the relationship and importance of Germany to the rest of Europe. 4 cr.

### 771,772. MODERN ENGLAND

From 1760 to the present. Social, intellectual, economic, and political transformation of the country as it developed into a major industrial nation and then adjusted to international and economic difficulties in the 20th century. 4 cr.

### 774. HISTORIOGRAPHY

Analysis of ancient and modern historians. Required of all entering Ph.D. candidates, open to undergraduates with permission of the instructor. 4 cr. (Alternate years; offered 1976-77).

### 775. HISTORICAL METHODS

An introduction to contemporary historical methods. Required of all entering Ph.D. candidates, open to undergraduates with permission of instructor. 4 cr. (Alternate years; offered 1977-78).



**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. Cross-cultural and multi-disciplinary. 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. Prerequisite: 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. Prerequisite: admission as an undergraduate major or graduate student in history, or permission of instructor. 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(797). COLLOQUIA IN HISTORY**

Selected topics in American, European, and non-Western history. Open to advanced undergraduate and graduate students. Prerequisite: permission of instructor. 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.

## Home Economics

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### (819,820). SEMINAR IN EARLY AMERICAN HISTORY

1) Mr. Clark (Social and Cultural), 2) Mr. Gilmore (Revolution), 3) Mr. Rutman (Anglo-American Society). Prerequisite: permission of instructor. 3 cr.

### (823,824). SEMINAR IN AMERICAN NATIONAL HISTORY

1) (Afro-American), 2) (Twentieth Century), 3) Mr. Jellison (Nineteenth Century and Biography), 4) Mr. Mennel (Social), 5) Mr. Long (Foreign Relations). Prerequisite: permission of instructor. 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. Heilbronner (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). Prerequisite: permission of instructor. 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 post-colonial eras. Among the topics will be: African resistance movements in pre-colonial and colonial Africa; African nationalism; problems of the independent African states; the role of the military in post-colonial 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

1) Early American History, 2) American National History, 3) Canada, 4) Latin America, 5) Medieval History, 6) Early Modern Europe, 7) Modern European History, 8) Ancient History, 9) Far East and India, 10) Near East and Africa, 11) European Historiography, 12) American Historiography, 13) Russia, 14) World History, 15) English History, 16) Historical Methodology. Staff. Prerequisite: permission of instructor. 3 cr.

### (899). MASTER'S THESIS

### (999). DOCTORAL RESEARCH

## Home Economics

**Chairperson:** Elizabeth Snell

**ASSOCIATE PROFESSORS:** Mary E. Holder, Elizabeth A. Snell

**ASSISTANT PROFESSORS:** Larry J. Hansen, Victor R. Messier

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, HE 897; and Research Project, HE 898 or Thesis, HE 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 2nd 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(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. Prerequisite: HE major and 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. Prerequisite: college course in biochemistry. (Also offered as AS 709.) 3 lec/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(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. Prerequisite: HE 627 or permission of instructor. 4 cr.

### 727. STUDENT TEACHING IN PRESCHOOL

Supervised teaching experience in a preschool setting. Students will spend five half days a week in a selected preschool working with a cooperating teacher. A weekly seminar will also be held on campus. Prerequisite: HE major—HE 525, 527, 626, 627, and permission of instructor. 6 cr.

### 754. PERSONAL AND FAMILY FINANCE

Financial alternatives available to individuals and families during stages of the family life cycle. 4 cr.

### 757. CONSUMER PROBLEMS

Consumer problems analyzed from the perspective of family, business, and government interests. Prerequisite: 8 cr. in consumer studies and permission of instructor. 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. Prerequisite: HE 573 and 506, a college course in biochemistry, and permission of instructor. 3 lec/1 lab/4 cr.

### (776). CONTEMPORARY ISSUES IN NUTRITION

Focus on national and worldwide nutrition concerns. Approaches and materials used in nutrition education. Prerequisite: HE 506, 573 or 575 and permission of instructor. 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. Prerequisite: HE 683, Psych 561. 4 cr.

### 791 (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

A critical review of current issues and literature; materials and methods for programs such as sex education and parent education. Prerequisite: Bio 409; HE 683 and permission of instructor. 4 cr.

### 893. PARENTS AND CHILDREN

An in-depth study of the reciprocal relationships among parents and children. Evaluation of service programs in terms of current research. Prerequisite: HE 626, 683 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: 1) clothing and textiles, 2) consumer education, 3) family relations, 4) food and nutrition, 5) home economics education, 6) management and family finance, and 7) 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. An introduction to 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 HE 897. 2-4 cr.

### 899. THESIS

6 cr.

### Institute of Natural and Environmental Resources

**Director:** David P. Olson

**Chairperson of Graduate Studies:** Robert D. Harter

**PROFESSORS:** Richard A. Andrews, James P. Barrett, James R. Bowring, Paul E. Bruns, Gordon L. Byers, William H. Drew, Owen B. Durgin, Francis R. Hall, William F. Henry, John L. Hill, Harold W. Hocker, Jr., Allan B. Prince

**ADJUNCT PROFESSORS:** George E. Frick, Nelson L. LeRay

**ASSOCIATE PROFESSORS:** Bennett B. Foster, 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

**ADJUNCT ASSISTANT PROFESSORS:** Peter W. Garrett, Douglas E. Morris

### Master of Science, Natural and Environmental Resources

A single master's degree is offered by the institute with five 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; evapotranspiration; and water conservation.

#### Resource Economics

Agricultural economics; community development; regional economics; land and water economics; rural manpower and population; economics of outdoor recreation; and marine economics.

#### Soil Science

Soil chemistry; soil classification and genesis; soil-plant relationships; and soil conservation.

#### 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.

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 which includes four or more courses in economics or resource economics. The Graduate Record Examination is also required of applicants to 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 3 courses in the areas of ecology or natural resources, and resource economics, or be expected to makeup 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, including the following course requirements or equivalent: INER 897-898 seminar, 2 credits; INER 803, Approach to Research, 2 credits; quantitative methods or analytical techniques; and directed research, 4-10 credits.
- 2) A final oral and/or written examination.

### Intercollege 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 their Ph.D. program,

which is coordinated through joint efforts of the soils and hydrology faculty 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 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

#### 701(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. Prerequisite: 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. Prerequisite: permission of instructor. 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, etc. USDA soil classification system; Soil Conservation Service rating criteria; N.H. soils. Guest lecturers. Prerequisite: permission of instructor. Mr. Peterson. 2 lec/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. Prerequisite: INER 528 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. Prerequisite: INER 528 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. Prerequisite: introductory courses in 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. Prerequisite: INER 635 or Res Econ 606 or permission of instructor. Mr. Tucker. 3 cr.

#### 735. POLLUTION OF WATER: CAUSES AND CONTROL

Problems in environmental pollution; scientific and technological aspects of pollution and pollution control; sources, effects, and control of water pollution, and its social, economic, and legal implications. Prerequisite: senior or graduate standing. Mr. Harter. 2 lec and weekly papers/4 cr.

#### 757. BASICS OF REMOTE SENSING

Application of photographic and non-photographic 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. Transportation fee. Mr. Bruns. 1-hr lec/2-hr lab/2 cr.

#### 758. APPLICATIONS OF REMOTE SENSING

Student project is developed using available conventional aerial photography or other imagery. Transportation fee. Prerequisite: INER 757 or equivalent. Mr. Bruns. 1-hr lec/2-hr lab/2 cr.

#### 797. FOREST RECREATION SEMINAR

Recreational use of non-urban lands; economics of public and private developments; planning for state and private recreational use, social aspects. Class project. Prerequisite: junior standing and permission of instructor. Mr. Wallace. Two 1-½ hour sessions/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. Mr. Drew, Mr. Hill. Prerequisite: permission of instructor. 2 cr.

## Institute of Natural and Environmental Resources

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### 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. Prerequisite: permission of instructor. 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. Prerequisite: permission of instructor. 4 cr.

### 815. LINEAR PROGRAMMING METHODS

Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications; non-linear programming, discrete programming; and solving input-output and game-theory problems. Mr. Andrews. Prerequisite: Elementary Matrix Algebra or permission of instructor. 2 cr.

### 897,898. NATURAL AND ENVIRONMENTAL RESOURCES SEMINAR

Presentation and discussion of recent research, literature, and policy problems in the natural and social sciences influencing resource use. Staff. May be repeated. 1 cr.

## Forest Resources

### 720. FOREST GENETICS

The genetics of forest tree improvement with emphasis on variation in natural populations, evolutionary principles and breeding methods. Prerequisite: PLS 604 (Zoo 604) and F.R. 629, or permission of instructor. Mr. Adams. 2 lec/1 lab/3 cr. (Alternate years, offered 1976-77.)

### 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). Prerequisite: F.R. 629 or equivalent and permission of instructor. Mr. Adams and Mr. Hocker. 4 cr.

### 734. FOREST PROTECTION SEMINAR

Discussion and special problems based on principles and techniques of forest protection. Prerequisite: FR 660, Forest 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 of instructor. Mr. Logsdon. 2 lec/1 rec/1 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 of instructor. Mr. Logsdon. 2 lec/1 rec/1 lab/4 cr.

### 745. FOREST MANAGEMENT

Production control; management objectives; forest production regulation and economic analysis; forest administration; professional responsibilities and opportunities. Prerequisite: completion of junior year in forestry curriculum. Transportation fee. Mr. Weyrick. 3 lec/1 lab/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. Mr. Foster. 2 lec/1 lab/4 cr.

### 754. WOOD PRODUCTS MANUFACTURE AND MARKETING

Wood products from harvesting and procurement of raw material to finished product processes; management decisions, marketing, and promotion problems. Visits to harvesting operations and manufacturing plants in New England. Transportation fee. Prerequisite: FR 426, or permission of instructor. Mr. Hill. 2 lec/1 lab/4 cr.

### 764. 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 and permission of instructor. 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: FR 745. Mr. Wallace. 2 lec/1 lab/4 cr.

### 801. FOREST MANAGEMENT SEMINAR

Seminar discussions of current literature, plans, and principles, and new developments in the general field of forest management. Prerequisite: permission of instructor. Mr. Bruns and members of the department. 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 of instructor. Mr. Hill. 2-hour sem/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 of instructor. Mr. Foster. 2-hour sem/2 cr. (Alternate years; offered 1977-78.)

### 809,810. WILDLIFE MANAGEMENT SEMINAR

Discussions and assigned reports on current investigations and developments in wildlife management. Prerequisite: undergraduate courses in wildlife management. Mr. Olson, Mr. Mautz, and Mr. Logsdon. 2-hour sem/1 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. The seminar is 2 credits with an additional 2 credits available for an in-depth study of a particular topic. Mr. Leak and Mr. Barrett. 2-4 cr.

### 895,896. INVESTIGATIONS IN 1) FOREST ECOLOGY, 2) PHOTOGRAMMETRY, 3) WOOD UTILIZATION, 4) GAME MANAGEMENT, 5) MENSURATION, 6) FOREST ECONOMICS, 7) FOREST MANAGEMENT, 8) OPERATIONS CONTROL AND ANALYSIS, 9) RECREATION, 10) POLICY, 11) WILDLIFE PHYSIOLOGY

Elective only after consultation with the instructor in charge. 1-4 cr.

### 899. THESIS

Hours and credits to be arranged to meet the needs of the individual student. Prerequisite: graduate standing and permission of instructor in the selected field of study. 6-10 cr.

## Resource Economics

### 705. PLANNED CHANGE IN NON-URBAN COMMUNITIES

#### APPLICATION

Application of community development theory and principles using appropriate research methodologies. Students participate in community development activities, and discuss problems and report on experience and progress in weekly seminars. May include placement in field agency. Prerequisite: Res Econ 508 or permission of instructor. Mr. LeRay. 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. Prerequisite: intermediate economic theory. Mr. Jansen. 4 cr.

### 707. RESEARCH METHODS IN SOCIAL SCIENCE

Scientific method; analysis of problems; design and application of research techniques. Can be used in place of Soc 702. Prerequisite: three hours of statistics. Mr. Drew. 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 non-lawyer 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. Prerequisite: intermediate economic theory, elementary statistics, calculus, linear programming, or permission of instructor. 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. Mr. Andrews. Prerequisite: INER 701 or equivalent, and Eco 605 or equivalent. 4 cr.

### 807. STATISTICAL ANALYSIS

Statistical measurement and research tools for use in the physical and social sciences. Regression, analysis of variance, factorial analysis, covariance, time series, sampling, and experimental design. 4 cr.

### 809. AGRICULTURAL ECONOMICS

Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision-making in food production, marketing, and consumption, and on the competitive structure of the food industry. Mr. Henry. 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. Prerequisites: Eco 605 and 611, or equivalent, and permission of instructor. 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. Prerequisite: elementary calculus, linear algebra, regression, micro- and macro-economics or permission of instructor. 4 cr. (Alternate years; offered 1976-77.)

### 895,896. INVESTIGATIONS IN RESOURCE ECONOMICS

Special assignments in readings, investigations, or field problems. May be repeated. 1) Community Development, 2) Economic Development Programs, 3) Economics of Natural Resources, 4) Human Resource Development, 5) Legal Problems of Resource Development, 6) Natural Resources Policy, 7) Production and Marketing of Agricultural Products, 8) Public Resource Policy, 9) Resource Investment Policy, 10) Water Economics. Prerequisite: permission of instructor. 2-4 cr.

### 899. THESIS

To be arranged. 6-10 cr.

## Soil and Water Science

### 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. Prerequisite: SWS 501 or permission of instructor. 3 lec/1 lab/4 cr.

### 702. CHEMISTRY OF SOILS

Chemical composition of soil; colloidal phenomena and the exchange and fixation of elements; cation exchange capacity and source of negative charge; inorganic reactions in soil and their effect on soil properties. Prerequisite: one year of college chemistry or permission of instructor Mr. Harter. 3 lec/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 man's uses of the soil. Transportation fee. Prerequisite: SWS 501 and an introductory geology course, or permission of instructor. Mr. Peterson. 3 lec/1 lab/4 cr.

### 705. PRINCIPLES OF HYDROLOGY

Physical and chemical processes and energy relations involved in the rainfall-runoff segment of the hydrologic cycle; surface outflow from a watershed with consideration given to sediment transport and water quality. Flow measurement, hydrometeorologic measurements, and hydrograph analysis. Mr. Hall. 3 lec/1 lab/4 cr.

### 710. GROUND-WATER HYDROLOGY

Principles governing occurrence, location, and development of ground water; well hydraulics, geophysical exploration, and chemical quality of water; use of fluid and electrical models, geophysical instruments, and selected problems. Basic course for hydrology majors and other qualified students. Mr. Hall. 3 lec/1 lab/4 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. Prerequisite: permission of instructor. Mr. Harter. 3 lec/3 cr.



**803. ADVANCED HYDROLOGY**

Provides a background for graduate students interested in water resource systems. Application of quantitative methods to selected problems in water resources. Major topics include ground-water flow, stream-aquifer relations, rainfall-runoff process, and water quality. Particular emphasis is placed on the approach of conceptualizing the problem, developing an appropriate model, and obtaining solutions by digital or analog simulation. Mr. Hall, Mr. Dingman. 3 cr.

**804. HYDROCHEMISTRY**

The 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 include equilibrium concepts, buffering mechanisms, oxidation-reduction reactions, and ion exchange. Particular 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. Mr. Hall. Prerequisite: two years of chemistry or equivalent, or permission of instructor. 2 lec/1 lab/3 cr.

**895-896. INVESTIGATIONS IN 1) SOIL-PLANT RELATIONSHIPS, 2) PHYSICS OF SOILS, 3) HYDROLOGY, 4) CHEMISTRY OF WATER, 5) CHEMISTRY OF SOILS, 6) SOIL CLASSIFICATION.**

Elective only after consultation with the instructor in charge. 1-4 cr.

**899. THESIS**

6-10 cr.

## Mathematics

**Chairperson:** M. Evans Munroe

**PROFESSORS:** Richard H. Balomenos, Edward H. Batho, Arthur H. Copeland, A. Robb Jacoby, Richard E. Johnson, Shan S. Kuo, M. Evans Munroe, Eric A. Nordgren, James A. Radlow, Shepley L. Ross, Robert J. Silverman

**ASSOCIATE PROFESSORS:** Homer F. Bechtell, Albert B. Bennett, Jr., William E. Bonnice, David M. Burton, Loren Meeker, Berrien Moore III, Samuel D. Shore, Donovan Van Osdol

**ASSISTANT PROFESSORS:** R. Daniel Bergeron, William Geeslin, Robert Russell, Albert O. Shar

The mathematics 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

**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 830-899. At least six of the ten must be from the 830-899 group.

### 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.

**Basic Degree Requirements:** 1) all of the courses numbered 833-842; 2) proficiency in reading mathematical literature in two of three languages: French, German, and Russian; 3) experience in teaching equivalent to at least half-time for one year; and 4) 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:** 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; new and original 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:** 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.

## Mathematics

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Courses numbered between 600 and 699 may be taken for graduate credit by non-majors 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 macro-programming. Input/output using system macros. Interrupts. Prerequisite: Math 410 or 510. 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. Prerequisite: Math 611. 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 towards a mathematics major only in mathematics-education. 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. Prerequisite: Math 526-528, Math 410 or equivalent. 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. Prerequisite: Math 527-528, Math 410 or equivalent. 4 cr.

### (647). COMPLEX ANALYSIS FOR APPLICATIONS

Complex numbers; complex integration; infinite series; contour integration; conformal mapping; Fourier and Laplace transforms; Wiener-Hopf techniques. Prerequisite: Math 528. 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. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1976-77.)

### 657. GEOMETRY I

Advanced approach to fundamental properties of Euclidean geometry. Prerequisite: Math 531. 4 cr.

### 658. GEOMETRY II

Systems of postulates of various geometries, geometric invariants, synthetic and analytic projective geometry, introduction to non-Euclidean geometry. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1977-78.)

### 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. Prerequisite: Math 527. 4 cr. (Alternate years; offered 1977-78.)

A maximum of four of the following courses may be applied to the degree of Master of Science in Mathematics.

### 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. Prerequisite: Math 611. 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. Prerequisite: Math 710. 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. Prerequisite: Permission of instructor. 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. Prerequisite: Math 528. 4 cr.

**736. STATISTICS**

Sampling theory, estimation of parameters, testing of hypotheses, non-parametric methods. Prerequisite: Math 735. 4 cr.

**753. NUMERICAL METHODS AND COMPUTERS I**

Use of numerical analysis on computers; high-level languages, compilers; linear and non-linear equations; interpolation, quadrature, curve fitting, system simulations, optimization techniques, finite elements, computer graphics. Selected algorithms will be programmed for computer solution. Prerequisite: Math 410 or 510, and 428. 4 cr.

**754. NUMERICAL METHODS AND COMPUTERS II**

Computer solutions of ordinary and partial differential equations, finite differences vs. finite elements, eigenvalues and eigenvectors, algorithms for hidden-line graphics. Mathematical software. Prerequisite: Math 410 or 510, and 527. 4 cr.

**761 (761). ABSTRACT ALGEBRA**

Basic properties of groups, rings, fields, and their homomorphisms. Prerequisite: Math 531. 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. Prerequisite: 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. Prerequisite: Math 761. 4 cr. (Alternate years; offered 1976-77.)

**767. ONE-DIMENSIONAL REAL ANALYSIS**

Theory of limits, continuity, differentiability, integrability, series, uniform convergence. Prerequisite: Math 528, 531. 4 cr.

**768. ABSTRACT ANALYSIS**

Metric spaces, function spaces, theory of uniform limits. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1977-78.)

**(769). MULTIDIMENSIONAL REAL ANALYSIS**

Partial derivatives, multiple integrals, line and surface integrals, Fourier series. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1976-77.)

**776. LOGIC**

Formal mathematics and formal systems. Consistency, completeness, decidability. Prerequisite: Math 531. 4 cr. (Alternate years; offered 1977-78.)

**780. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS**

Fundamental existence and uniqueness theorems; linear systems and higher order linear equations; Wronskian theory; classical Sturm Theorem and generalizations; boundary value problems for second order linear equations. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1976-77.)

**781. PARTIAL DIFFERENTIAL EQUATIONS**

First order equations; linear second order equations; Cauchy problem; Dirichlet problem; application to physics. Prerequisite: Math 767. 4 cr. (Alternate years; offered 1977-78.)

**(784). TOPOLOGY**

Connectedness, compactness, metrizability, with special emphasis on real line and plane. Prerequisite: Math 531. 4 cr.

**(785). ALGEBRAIC METHODS IN TOPOLOGY**

Topology of manifolds, topological groups, homology, knot theory. Prerequisite: Math 784. 4 cr. (Alternate years; offered 1977-78.)

**(786). CALCULUS ON MANIFOLDS**

Differentiable manifolds; differential forms; exterior and Grassman algebras; integration of differential forms; Stokes theorem; closed and exact differential forms. Not for credit if credit received for Math 769. Prerequisite: Math 762 and 767. 4 cr. (Alternate years; offered 1976-77.)

**(787). DIFFERENTIAL GEOMETRY**

Introduction to Lie groups and frame bundles; differential invariants of surfaces and curves; local theory of surfaces. Prerequisite: Math 786. 4 cr. (Alternate years; offered 1976-77.)

**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. Prerequisite: 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

## Mathematics

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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.

### 816. 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. 3 cr.

### 835. MEASURE AND INTEGRATION

Outer measures and measures; Lebesgue integrals; convergence theorems. 3 cr.

### 836. FUNCTIONAL ANALYSIS

Banach spaces; representation of linear functionals; weak and weak\*-topologies. 3 cr.

## 837-838. COMPLEX ANALYSIS

Complex variables and functions; analytic functions; complex integration; series and products; conformal mapping; analytic continuation and Riemann surfaces. 3 cr.

## 839-840. GENERAL TOPOLOGY

Topological spaces; nets and filters; product and quotient spaces; embedding and metrization; compact spaces; uniform spaces; homotopy and fundamental group; covering spaces and fibrations. 3 cr.

## 841-842. ALGEBRAIC TOPOLOGY

Chain complexes; homology of simplicial complexes, singular homology and cohomology; axiomatic homology; cup and cap products; topological manifolds; sheaves. 3 cr.

The following are advanced courses primarily for Doctor of Philosophy candidates, though they may be elected by qualified Master of Science candidates. In each of these the content will vary from year to year. Thus, with permission of the instructor, each of these courses may be taken more than once for credit, even concurrently. Normally, the content will be chosen from among the topics listed.

## 861-862. TOPICS IN ALGEBRA

3 cr.

## 863, 864. TOPICS IN ANALYSIS

3 cr.

## 865, 866. TOPICS IN TOPOLOGY

3 cr.

## 867, 868. TOPICS IN GEOMETRY

3 cr.

## 869, 870. TOPICS IN FUNCTIONAL ANALYSIS

3 cr.

## 871, 872. TOPICS IN DIFFERENTIAL EQUATIONS

3 cr.

## 873, 874. TOPICS IN APPLIED MATHEMATICS

3 cr.

## 875, 876. TOPICS IN PROBABILITY AND STATISTICS

3 cr.

## 877, 878. TOPICS IN LOGIC AND FOUNDATIONS

3 cr.

## 879, 880. TOPICS IN MATHEMATICS EDUCATION

3 cr.

## 898. READING COURSES

Offered in the following areas: (a) Algebra, (b) Analysis, (c) Topology, (d) Geometry, (e) Functional Analysis, (f) Differential Equations, (g) Applied Mathematics, (h) Probability and Statistics, (i) Mathematics Education, (j) Computer Science. 3-6 cr.

## 999. DOCTOR OF PHILOSOPHY THESIS

# Mechanical Engineering

Chairperson: William Mosberg

PROFESSORS: Robert W. Corell, Godfrey H. Savage, Charles K. Taft, Asim Yildiz

ASSOCIATE PROFESSORS: E. Eugene Allmendinger, Wayne M. Beasley, Frederick G. Hochgraf, David E. Limbert, William Mosberg, Russell L. Valentine, John A. Wilson

ASSISTANT PROFESSOR: Barbaros Celikkol

LECTURER: 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 course work in addition to Mechanical Engineering 899, Master's Thesis; the project plan requires 30 semester hours of course work 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 72.

# Mechanical Engineering

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Students completing degree requirements through the Division of Continuing Education must be admitted to the Graduate School and have their programs approved by the department.

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. 4 cr.

## 702. STATISTICAL THERMODYNAMICS

Macroscopic thermodynamic principles developed by means of microscopic analysis. Prerequisite: ME 503. 4 cr.

## 703. HEAT TRANSFER

Analysis of phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. Prerequisite: ME 508 or taken concurrently. 3 cr.

## 704. EXPERIMENTAL HEAT TRANSFER

Methods in the study and solution of problems, including a critical comparison with analytical and other methods. Prerequisite: ME 703. 4 cr.

## 707. ANALYTICAL FLUID DYNAMICS

Potential flow, development of the Navier-Stokes equations, turbulence and boundary-layer theory. Prerequisite: ME 508. 4 cr.

## 708. GAS DYNAMICS

Basic equations of motion of one-dimensional, subsonic and supersonic flows of compressible, ideal fluids. Wave phenomena. Rankine-Hugoniot relations. Linear approach to two-dimensional flow problems. Prerequisite: ME 508. 4 cr.

## 715. INTERNAL COMBUSTION ENGINES

Basic and engineering science applied to spark and compression-ignition engines; design, management, and reporting of experimental studies. Prerequisite: ME 503. 4 cr.

## 716. PROPULSION SYSTEMS

Basic engineering sciences applied to the engineering problems of propulsion systems. Prerequisite: ME 508. 4 cr.

## 717. CYROGENICS

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. Prerequisite: ME 503. 4 cr.

## 723. ADVANCED DYNAMICS

Classical dynamics oriented to contemporary engineering applications. Review of particle dynamics. Hamilton's principle and the Lagrange equations. Kinematics and dynamics of rigid bodies, gyroscopic effects in machinery and space structures. 4 cr.

## 724. VIBRATION THEORY AND APPLICATION

Theory of discrete vibrating systems. Single-degree-of-freedom system with general excitation. Matrix theory and eigenvalue problems. Many degrees of freedom. Numerical methods. Continuous systems. Applications to structural and mechanical systems. Prerequisite: ME 628 or graduate standing. 4 cr.

## 726. EXPERIMENTAL MECHANICS

Experimental methods and theoretical bases applied to measurement of stress, strain, and motion. Transmitted and scattered-light photoelasticity; strain gage applications; brittle coating and grid techniques; dynamic measurements, and associated instrumentation. 4 cr.

## 727. ADVANCED MECHANICS OF SOLIDS

Beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 cr.

## 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. Prerequisite: ME 508 and 523, 524; Math 527, 528. 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. Prerequisite: ME 737; ME 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. 4 cr. (Also offered as EE 745.)

## 751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING

Architectural principles related to surface and submerged vehicles. Hydrostatic characteristics, fundamentals of powering, and rules and regulations. Prerequisite: ME 508 or permission of instructor. 4 cr.

## 752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN

Historical perspective, environmental factors, hydromechanic and structural principles, materials, intra-vehicle systems, extra-vehicle systems, operating considerations, pre-design and design procedures. Conceptual and basic preliminary designs of selected submersible vehicles are prepared by student teams. 4 cr.

## 757. COASTAL ENGINEERING AND PROCESSES

Water waves and their effects. Equations for surface waves and laboratory tank demonstration of wave trains, beat waves, 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. 3 lec/1 lab/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 non-crystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation, crystal growth, and solid-state reactions; kinetics of grain growth, sintering, and vitrification. 4 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.

## 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. Prerequisite: Permission of instructor. 3 rec/1 lab/4 cr. (Also offered as EE 782.)

## 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

Non-equilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prerequisite: ME 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. Prerequisite: ME 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, thermoelastic and non-linear gas, liquid, and elastic fields. General discussion of rheological behavior. Causality conditions for continuum fields. Examples for solids, liquids, and gases, and biomechanics. Introduction to phenomenological Lagrangian theories. 4 cr.

### 824. VIBRATIONS OF CONTINUOUS MEDIA

Classical and numerical methods are employed to study the vibration of continuous elements and structures. Topics considered are axial and torsional vibration of rods, transverse vibration of beams and thin plates, wave propagation, and vibration of simple structures. 4 cr.

### 826. THEORY OF ELASTICITY

The analysis of stress and deformation in elastic solids; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; elastodynamic fields; inhomogeneous, anisotropic, wave equations; wave propagation, and stress concentration problems; generalizations to thermoelasticity and viscoelastic fields. Complex variable techniques will be used. 4 cr.

### 827. THEORY OF PLASTICITY

Analysis of stress and deformation in inelastic solids; general development of stress invariants, variational principles, constitutive relations, and yield and loading functions. Special emphasis on ideal plasticity, strain-hardening, creep, limit analysis, and limit design. 4 cr.

### 829. THEORY OF PLATES AND SHELLS

Theory of elasticity developed for plates and shells; conservation laws for elastic media; stress and strain relations by continuous functions; Airy stress functions; stress and strain relations in curvilinear coordinates; thin and thick plate and shell theories; vibration of spherical, cylindrical, and conical shells and plates. 4 cr.

### 838. THEORETICAL ACOUSTICS

Fundamentals are presented with emphasis on theory and applications in underwater acoustics and in the acoustic determination of dynamic material properties. Topics include: a review of vibration theory; derivation of nonlinear acoustic field equations; linearization; Green's function techniques and solution of boundary value problems; scattering, reflection theories of boundary roughness; development of ray theory (geometric optics) from field equations; and Eikonal approximations. 4 cr.

### 842. DISCONTINUOUS CONTROL

The 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 EE 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. Prerequisite: ME 851. 4 cr.

### 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. Prerequisite: ME 782. 3 cr. (Also offered as EE 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. Prerequisite: ME 851. 3 cr. (Also offered as EE 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 ME 781 which is a prerequisite. 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. 4 cr.

**883. TENSOR ANALYSIS AND DIFFERENTIAL GEOMETRY**

Mathematical groundwork for applied group theory, transformation groups, affine groups and affine geometry. Coordinate transformations and point transformations. Affinors, tensors, and their algebraic properties. Invariant differential operators. Lie derivative, holonomic and anholonomic coordinate systems. Curvature tensor, Bianchi identity, tensor densities. Green's theorem, Green's functions, potential functions. Pfaff's problem. 4 cr.

**890 a-d and 891 a-d. SPECIAL TOPICS IN ENGINEERING**

Course 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 and 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**

**Chairperson:** Galen E. Jones

**PROFESSORS:** William R. Chesbro, Galen E. Jones, Theodore G. Metcalf, Lawrence W. Slanetz

**ASSISTANT PROFESSORS:** Thomas G. Pistole, Robert M. Zsigray

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 demonstrate proficiency in reading microbiological literature in one foreign language, usually French or German; 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 immunologic aspects of bacterial host-parasite interactions, analysis of microbial structures at cellular and molecular levels, bacterial and bacteriophage genetics, studies of viruses pathogenic for man and animals, cell culture phenomena, public health and sanitary aspects of microbiology and virology, and marine microbiology.

**702. PATHOGENIC MICROBIOLOGY**

The morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Prerequisite: Micro 503. 2 lec/2 lab/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 antisera in animals. Prerequisite: Micro 702. 2 lec/2 lab/4 cr.

## Music

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### 706. VIROLOGY

Viruses, including animal and bacterial, and rickettsiae; interaction of viruses and host cells; technics for propagation and recognition including immunologic methods; applications to infectious disease, the environment, and cancer. Prerequisite: Micro 702. 1 lec/3 lab/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. Prerequisite: Micro 503 and organic chemistry. 2 lec/1 lab/4 cr.

### 708. MICROBIAL BIOGEOCHEMISTRY

Geochemical processes influenced by biochemical processes catalyzed by marine and terrestrial microorganisms; transformations of carbon, nitrogen, and other elements. Petroleum microbiology, natural gas production, sulfur formation, ferromanganese nodules, corrosion, and fossil microorganisms. Prerequisite: Micro 503 and organic chemistry. 2 lec/1 lab/4 cr.

### 795,796. PROBLEMS IN MICROBIOLOGY

Prerequisite: permission of department chairperson and staff. Cr. to be arranged.

### 800. SYSTEMATIC MICROBIOLOGY

Procedures, methods for classification of microorganisms; review of systems of classification. Prerequisite: one year of microbiology. 2 lec/1 lab/4 cr.

### 802. MICROBIAL PHYSIOLOGY

Means by which microorganisms survive: nutritional, chemical, physical factors; metabolism and its regulation; generation of cell ultrastructure; ecological interactions. Prerequisite: Micro 503, General Biochemistry (not to be taken concurrently). 2 lec/1 lab/4 cr.

### 804. MICROBIAL GENETICS

Expression, regulation, recombination and transmission of genetic information in procaryotic and eucaryotic microorganisms. Consideration of chromosomal and extrachromosomal inheritance. Prerequisite: Micro 503 and permission of instructor. 2 lec/1 lab/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. Prerequisite: Micro 503 and permission of instructor. Also offered as AS 851. 2 lec/1 lab/4 cr.

### 897-898. MICROBIOLOGY SEMINAR

Reports, discussions, microbiological literature, and current developments in microbiology. Prerequisite: permission of instructor. 1 cr.

### 899. MASTER'S THESIS

6-10 cr.

### 999. DOCTORAL RESEARCH

## Music

**Chairperson:** Paul Verrette

**PROFESSORS:** Donald Steele, John Wicks

**ASSOCIATE PROFESSORS:** Mark DeVoto, Alan Grishman, Cleveland Howard, Keith Polk, Mary Rasmussen, John Rogers, John Whitlock, Henry Wing, Jr.

**ASSISTANT PROFESSORS:** Stanley Hettinger, Niel Sir, Paul Verrette

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

At the University of New Hampshire the degree of Master of Arts in Music is designed for students interested in broadening their knowledge of the history of music, but at the same time it offers ample opportunity to pursue more specialized studies in music theory, performance, performance-practice, or music literature. The following courses are required: Music 855, 856, 857, 858, 891, 893 or 894, or their approved equivalents. The student may elect courses in the 700 series in music or the 600, 700, and 800 series in other departments with the permission of the students adviser. The department recommends that a student allow more than two semesters for completion of the program.

The department requires a Bachelor of Arts degree in Music or its equivalent from an accredited institution for admission to this program. Placement examinations in theory, music history, and aural identification are 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 be required to make up their deficiencies.

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. Oral examinations are required of all Master of Arts degree candidates.

## 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: Music 855; 893 or 894; Music Education 796; 883 or 884. Also required are 2 courses in the Department of Education from courses such as the following: Education 820, 827, 841, 853, 858, 861, 865, 883, 884, 886, and the 700 courses. 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 be required to make up deficiencies.

## Music (71)

### 701. MUSIC OF THE MEDIEVAL PERIOD

The nature of the beginnings of polyphony. The pre-eminent 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 listening, reading, 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.

### 754 (754). COLLEGIUM MUSICUM

Instrumentalists and singers perform small ensemble music from all periods, with emphasis on Renaissance and Baroque music. Prerequisite: permission of instructor. 1 cr.

### 755 (755). PERFORMANCE STUDIES IN MEDIEVAL MUSIC

Performance of vocal, vocal-instrumental, and instrumental ensemble, circa 1100 to 1450; rhythm, *musica ficta*, notation, melodic ornamentation, improvised polyphony, and the clear projection of a polyphonic texture. Evaluation of the writings of selected medieval theorists and modern scholars; practical exercises in transcription; and performance on reconstructions of medieval instruments, especially the organ, harp, psaltery, rebec, vielle, and recorder. 2 or 4 cr.

## 756 (756). PERFORMANCE STUDIES IN RENAISSANCE MUSIC

Problems of musical performance, circa 1450 to 1600, via the small vocal, vocal-instrumental, and instrumental ensemble; rhythm and tempo, *musica ficta*, text underlay, articulation, diminution, tablature notation, and effective distribution of voices and instruments. Survey of performance manuals, iconographical sources, and current research; development of editing technique through the preparation of transcriptions; and an opportunity to perform on the organ, harpsichord, lute, viols, recorders, cornets, and trombones. 2 or 4 cr.

## 757 (757). PERFORMANCE STUDIES IN BAROQUE MUSIC

Performance practices in solo keyboard works, sonatas a2 and a3 and solo cantatas, circa 1640 to 1750, concentrating on ornamentation, realization of figured basses, improvisation, articulation, rhythm, keyboard registration, and the influence of the construction of baroque musical instruments (including the organ) on sonority and technique. Course work includes an examination of manuscripts (on microfilm), prints, treatises, and iconographical sources and the editing and realization of selected works for recital performance. 2 or 4 cr.

## 758 (758). PERFORMANCE STUDIES IN CLASSICAL MUSIC

Performance of keyboard music and instrumental chamber music, circa 1760 to 1815, emphasizing the relationship between structure and interpretation, late 18th century conventions of ornamentation and articulation, a survey of tutors and relevant theoretical writing, and a critique of currently published editions and editing techniques. 2 or 4 cr.

## 759 (759). PERFORMANCE STUDIES IN 19th CENTURY MUSIC

Performing and coaching Lieder, piano music, and instrumental chamber music from Schubert through Debussy; effective ensemble, traditions of interpretation, and the influence of structure on performance. 2 or 4 cr.

## 760 (760). PERFORMANCE STUDIES IN 20th CENTURY MUSIC

Small instrumental or vocal-instrumental ensembles, with intensive work in structural analysis, rhythmic ensemble coordination, dynamic and articulation control, new instrumental techniques, notation, improvisation, and the interaction between jazz and European styles. 2 or 4 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. Prerequisite: Mu 572 or permission of instructor. 2 cr.

## 773. CANON AND FUGUE

A continuation of Mu 772. The procedures of polyphonic tonal textures through the analysis and composition of canons and fugues. Prerequisite: Mu 772 or permission of instructor. 2 cr.

## 775-776. COMPOSITION

Construction of phrases, periods, and short compositions following classical models. Problems of text-setting. Prerequisite: Mu 572 or permission of instructor. 3 cr.

## 777-778. ADVANCED COMPOSITION

A continuation of Mu 776. Individual compositional projects. Prerequisite: Mu 776 and permission of instructor. 3 cr.

## 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. Prerequisite: Mu 572 or permission of instructor. 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. Prerequisite: Mu 572 or permission of instructor. 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 K110 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. Prerequisite: permission of instructor. 4 cr.

## 795. SPECIAL STUDIES IN MUSIC EDUCATION

Allows upper-level students to explore, individually or in groups, areas related to their specific professional interests. Prerequisite: permission of instructor. 1-4 cr.

## 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. Prerequisite: student must exhibit sufficient proficiency to warrant graduate study and 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 (841). GRADUATE VOICE

842 (842). GRADUATE PIANO

843 (843). GRADUATE HARPISCHORD

844 (844). GRADUATE ORGAN

845 (845). GRADUATE VIOLIN, VIOLA

846 (846). GRADUATE VIOLONCELLO, STRING BASS

847 (847). GRADUATE WOODWIND

848 (848). GRADUATE BRASS

849 (849). GRADUATE PERCUSSION

850 (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. Prerequisite: permission of instructor. Variable cr.

### 893. THEORY SEMINAR

Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to Monteverdi. Prerequisite: permission of instructor. 3 cr.

### 894. THEORY SEMINAR

Theory and practice from the Baroque to contemporary music. Performance practice in the Baroque and later periods. Score analysis. Prerequisite: permission of instructor. 3 cr.

### 895. INDEPENDENT STUDY IN THE HISTORY AND THEORY OF MUSIC

This course provides the opportunity for especially qualified students to investigate with guidance specific areas of their scholarly concern. Prerequisite: permission of instructor. 1-4 cr.

## Music Education

### 741-742. TECHNIQUES AND METHODS IN CHORAL MUSIC

Problems in the organization and performance of high school, college, and community choruses. Techniques of choral conducting and rehearsal, repertory, and materials. 2 cr.

### 743. MATERIALS AND METHODS IN PIANO MUSIC

Gives potential piano teachers a coherent but flexible approach to the instruction of students of different ages and levels of talent through evaluation of methods and materials and discussion of the role of the private teacher. 2 cr.

### 745-746. TECHNIQUES AND METHODS IN STRING INSTRUMENTS

Class and individual instruction. Four hours practice per week required. Intensive training on the violin, viola, cello, and double bass, enables participants to perform in string ensembles. Classroom procedures, establishment of string programs, and evaluation of available methods materials. 2 cr.

### 747-748. TECHNIQUES AND METHODS IN WOODWIND INSTRUMENTS

Basic fundamentals of performance, class instruction, associated acoustical problems, and study of woodwind literature. First semester: clarinet, flute, and saxophone. Second semester: double-reed instruments. 2 cr.

## Occupational Education

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### 749-750. 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.

### 751. 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.

### 785. 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.

### 787-788. 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.

### 791-792. 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.

### 795. SPECIAL STUDIES IN MUSIC LITERATURE

Presumes a sound musical background. Barring duplication of material, this course may be repeated for credit. Prerequisite: permission of instructor. 1-4 cr.

### 796. 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.

### 895. SPECIAL PROJECTS IN MUSIC EDUCATION

Independent study, investigation, or research in music education. Creative projects may be included. Prerequisite: permission of instructor. 1-4 cr.

## Occupational Education

**Chairperson:** William H. Annis

**PROFESSORS:** William H. Annis, Maynard Heckel

**ASSOCIATE PROFESSOR:** Richard Barker

**ASSISTANT PROFESSOR:** Nicholas L. Paul

**THOMPSON SCHOOL PROFESSOR:** Paul A. Gilman

**THOMPSON SCHOOL ASSOCIATE PROFESSOR:** Lewis Roberts, Jr.

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 Millers 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 option. Candidates completing a thesis will be required to complete an oral examination. Students following the non-thesis option will be required to complete both written and oral examinations. For further information contact Chairperson W.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.

### **750. SHOP ORGANIZATION AND CONTROL METHODS**

Efficiency in the control of instruction, equipment, and materials. 4 cr.

### **783. PREPARATION FOR CONDUCTING AND SUPERVISING ADULT-EDUCATION PROGRAMS**

Techniques of needs identification, program planning; teaching methods, supervision, and evaluation. Prerequisite: OcEd 550 or permission of instructor. 4 cr.

### **784. 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.

### **785. 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 of instructor. 4 cr.

### **786. 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 post-secondary schools. Coordination of programs with general education and other vocational fields. 4 cr.

### **787. ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION**

A study of the forces which require special competencies to supervise and administer vocational education. An examination of operating philosophies 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, the function of consulting committees, working with youth groups, program evaluation. Course is scheduled concurrently with Ed 694. Prerequisite: Oc Ed 650. 4 cr.

### **796. INVESTIGATIONS IN OCCUPATIONAL EDUCATION**

1) Career Education 2) Secondary Education 3) Post-Secondary Education 4) Adult Education 5) Extension Education 6) Exemplary Programs 7) Cooperative Education Programs 8) 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.

### **798. OCCUPATIONAL EDUCATION SEMINAR.**

Discussion of current issues, problems, and research and development in Oc Ed. Students, faculty, and other personnel are utilized as discussion leaders. Required of Oc Ed 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 non-production phases of vocational agriculture. The development of teaching plans, techniques of instruction, and the development of multi-media teaching units will be stressed. 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. Prerequisite: a course in teaching methods or permission of instructor. 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.

## Physical Education

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### 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 the candidate's 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 which 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 inter-relation of data and reporting. 4 cr.

### (895). INDEPENDENT STUDY IN OCCUPATIONAL EDUCATION

Individual study problems in various phases of occupational education. Prerequisite: permission of staff. 2-6 cr. May be repeated.

### 899. MASTER OF OCCUPATIONAL EDUCATION THESIS

6-10 cr.

## Physical Education

**Chairperson:** Robert Kertzer

**ASSOCIATE PROFESSORS:** Katherine Amsden, Gavin H. Carter, Phyllis A. Hoff, Robert Kertzer, Robert E. Wear, Walter E. Weiland  
**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 (student must submit GRE scores for the aptitude test), and letters of recommendation. An applicant must be an above-average student 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.

A student may satisfy program requirements for the master's degree through either thesis or non-thesis program options. 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 Option:** A minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) are required in the thesis option. 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.

**Non-thesis Option:** A minimum of 32 approved graduate credits are required in the non-thesis option. Four credits of either Physical Education 895 or 896 (Advanced Studies) are required. A student may take one of the Advanced Studies courses only after having completed at least 20 approved graduate credits, including Physical Education 801 and Natural and Environmental Resources 701. All course work 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. Training room facility administration. Prerequisite: P.E. 502. lec/lab/4 cr.

### 703. LABORATORY PRACTICE IN ATHLETIC TRAINING

150 hours of experience in UNH athletic training room under N.A.T.A. certified trainer. Prerequisite: P.E. 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. Prerequisite: PE 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. Prerequisite: PE 775, PE 540, or permission of instructor. 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. Prerequisite: Psych 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. Prerequisite: Psych 401 or PE 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.

**(801). RESEARCH METHODS IN PHYSICAL EDUCATION**

Research techniques and methodology, hypothesis formulation, format of research report, and critical reading of current research. Prerequisite: INER 701, or equivalent. 4 cr.

**831. CONDITIONING FOR MAXIMUM PERFORMANCE**

Examination of the anatomical and physiological factors related to maximum physical performance. Evaluation of present programs of training. Prerequisite: PE 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. Prerequisite: 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. Prerequisite: PE 775, or equivalent. 4 cr.

**895, 896. ADVANCED STUDIES**

Provides advanced work either on a group-seminar or an independent-study basis. Investigation, presentation, and discussion of recent studies of special concern to physical education. 2-6 cr.

**899. MASTER'S THESIS**

6 cr.

## Physics

**Chairperson:** John E. Mulhern, Jr.

**PROFESSORS:** Roger L. Arnoldy, L. Christian Balling, Edward L. Chupp, Robert E. Houston, Jr., Richard L. Kaufmann, Robert H. Lambert, John A. Lockwood, Lyman Mower, John E. Mulhern Jr., William R. Webber  
**ASSOCIATE PROFESSORS:** John F. Dawson, Harvey K. Shepard, Robert E. Simpson  
**ASSISTANT PROFESSORS:** Barry J. Harrington, John J. Wright  
**GRADUATE ADVISER:** Robert H. Lambert

The physics department offers courses leading to three graduate degrees: Master of Science for Teachers, Master of Science, and Doctor of Philosophy. Graduate students entering in the Master of Science and Doctor of Philosophy programs are expected to demonstrate a proficiency in undergraduate work equivalent to that of the senior year in physics at the University of New Hampshire.

All Ph.D. candidates in physics are required to take a preliminary, comprehensive, written qualifying exam at the beginning of the fall semester of their second year. Exceptions are possible by petition only. This exam will emphasize quantum mechanics, electricity and magnetism, and classical mechanics at the undergraduate and first-year graduate level. It will be given on two days, each part being approximately four hours in duration. Students who fail to qualify at either level must take the written examination a second time in February of the same academic year. Students are allowed two attempts to pass the qualifying exam. Ph.D. students qualifying in the written exam will be required to take an oral exam within one month of passing the written examination.

### Master of Science for Teachers

The degree of Master of Science for Teachers is offered for candidates who satisfy the general admission requirements (see page 13) or who hold a secondary school teacher certification in physics or in general physical science. The courses leading to this degree will normally be chosen so as to improve the candidate's ability to teach physics or general physical science at the secondary school level. These courses should total at least 30 semester hours and should be chosen in consultation with the graduate adviser in physics.

M.S.T. students are not required to take the qualifying examination. Persons interested in this degree should confer with the department chairperson or graduate adviser.

## Master of Science Degree

For admission to graduate study in Physics leading to a Master of Science degree, the student should have completed 24 to 30 semester hours of undergraduate courses in physics. Suitable undergraduate preparation in mathematics is essential to graduate study in physics and should include differential equations, linear algebra, and advanced calculus. Candidates for admission are also required to take the Graduate Record Examination (both the aptitude test and the advanced test in Physics). The results of this examination will be used in conjunction with transcripts to evaluate the applicant's undergraduate training. The courses required for a Master of Science degree include Physics 833, 839, 841, and 843. Candidates may select one of the following two options:

- 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 in physics leading to a Doctor of Philosophy degree, the student should satisfy the same general admission requirements as for a Master of Science degree. In addition, the student is expected to demonstrate an outstanding proficiency in undergraduate physics. Admission to candidacy for the degree is based on demonstrated ability in formal course work, satisfaction of the language requirement, experience in teaching, equivalent to at least half-time for one year; and the passing of a written and oral qualifying examination as specified above. Finally, upon completion of a thesis, the doctoral candidate will take an oral examination based on the area of research.

The courses required for a Doctor of Philosophy degree 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 space physics, one of these five courses must be 850 or 852.) Note that 895 may be taken more than once for credit.

The language requirement consists of demonstrating a reading ability in one of the following foreign languages: German, French, or Russian. This requirement may be satisfied by any one of the following methods:

- 1) Satisfactory performance on the Educational Testing Service foreign language examination.
- 2) Satisfactory performance on the reading examination administered by the department.
- 3) After two attempts at either 1) or 2), the requirement may be satisfied only by the completion of a one-year course in the language.

### 607. PHYSICAL OPTICS

Electromagnetic theory of light, interference, diffraction polarization, related phenomena, and non-linear optics. Prerequisite: Math 528. 4 cr.

### 701. INTRODUCTION TO QUANTUM MECHANICS

Applications to atomic and molecular spectra. Prerequisite: Math 527, 528 and consent of instructor. 4 cr.

### 702. ATOMIC AND NUCLEAR PHYSICS

Natural radioactivity; nuclear reactions and scattering; models of the nucleus; high energy nuclear physics; cosmic rays. Prerequisite: Phys 701. 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. Prerequisite: Math 527, 528 and consent of instructor. 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 phenomenon. Prerequisite: passing an electronics proficiency test or Phys 605. 3 cr.

### 834. EXPERIMENTAL PHYSICS II

Modern research techniques. Prerequisite: 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 are among the topics discussed. Prerequisite: Phys 831 and 843 or permission of instructor. 3 cr

### 836. STATISTICAL PHYSICS II

Basic formulation and application of statistical mechanics to selected physical problems. Prerequisite: Phys 844. 3 cr. (Offered on request.)

**839. THEORETICAL MECHANICS**

Newtonian, Lagrangian, and Hamiltonian formulation of the classical mechanics of particles and rigid bodies, with particular attention to those topics that serve as background for the study of modern physical theories. 3 cr.

**841-842. ELECTROMAGNETIC THEORY**

The formulation and detailed application of electromagnetic theory to physical problems. Prerequisite: permission of instructor. 3 cr.

**843-844. QUANTUM MECHANICS**

Wave mechanical and Dirac formulations of non-relativistic quantum mechanics. Prerequisite: permission of instructor. 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.

**852. PLASMA PHYSICS II**

Topics to be discussed will be selected from the following: kinetic theory of plasmas, plasma waves, instabilities, and non-linear plasma phenomena. Offered on request. Prerequisite: Phys 835 or permission of instructor. 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. Prerequisite: Phys 839 and 844. 3 cr. (861-alternate years; offered 1977-78. 862 offered on request.)

**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. Prerequisite: Phys 844. 3 cr. (863-alternate years; offered 1976-77. 864 offered on request.)

**865-866. SOLID STATE PHYSICS**

Development of quantum mechanical theory of solids, transport phenomena, etc. Prerequisite: Phys 843 and 835. 3 cr. (865-alternate years; offered 1977-78. 866 offered on request.)

**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.

**888. COSMIC PHYSICS II**

Extended investigation of one or more of the topics introduced in Cosmic Physics I. Offered on request. 3 cr.

**889-890. 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.

**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. Choice of topic to be determined by class. May be taken more than once. 1-3 cr.

**897-898. COLLOQUIUM**

Required of all graduate students. Topics to be selected. No cr.

**899. MASTER'S THESIS**

6 cr.

**999. DOCTORAL RESEARCH**

### Plant Science

**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, J. Brent Loy, Jerry Warren, Otho S. Wells

**ASSISTANT PROFESSORS:** David W. Koch, James E. Pollard

**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 regulating plant growth: 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, growth and development; and growth regulations. 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.

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 of each master's and doctoral student.

### Advanced Plant Physiology

#### 708. PLANT NUTRITION

Nutritional aspects of higher plants; uptake, translocation, and metabolic role. Prerequisite: plant physiology, soils. Mr. Estes. 3 lec/1 lab/4 cr. (Alternate years; offered 1976-77.)

#### 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. Prerequisite: Biochem 601 or 751. Mr. Routley. 2 or 4 cr. (Alternate years; offered 1976-77.)

#### 863. PLANT GROWTH AND DEVELOPMENT

Biochemistry and physiology of growth and development; current research; independent laboratory projects. Prerequisite: Plant Physiology and Biochemistry. Mr. Pollard. 2 lec/2 lab/4 cr. (Alternate years; offered 1977-78.)

### 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. Prerequisite: Zoo or PS 604 and FR 528, or equivalents, or permission of instructor. Mr. Kiang. 4 lec/4 cr. (Alternate years, offered 1976-77.)

#### 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. Prerequisite: introductory genetics and physiology. Mr. Loy. 3 lec/1 lab/4 cr. (Alternate years; offered 1977-78.)

#### 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. Prerequisite: Zoology or PS 604, or equivalent, or permission of instructor. Mr. Kiang. 4 lec/4 cr. (Alternate years; offered 1977-78.)

#### 773. METHODS AND THEORY OF PLANT BREEDING

Plant breeding systems for qualitative and quantitative plant improvement. Prerequisite: PS or Zoo 604, Forestry 528, or permission of instructor. Mr. Peirce. 3 lec/3 cr. (Alternate years; offered 1976-77.)

#### 851. PLANT GENETICS

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 cr. (Alternate years; offered 1977-78.)

#### 853. CYTOGENETICS

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory techniques in cytogenetic analysis. Mr. Rogers. Prerequisite: Genetics, Cytology. 2 lec/1 lab/3 cr. (Alternate years; offered 1976-77.)

## General Offerings and Independent Studies

### 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. Prerequisite: inorganic chemistry and physics. Mr. Estes. 2 lec/2 lab/4 cr.

### 795, 796. ADVANCED TOPICS IN PLANT SCIENCE

Independent research, study, or group discussion. A) physiology, Mssrs. Estes, Koch, Pollard, Routley. B) Genetics, Mssrs. Estes, Koch, Pollard, Routley. c) Plant Utilization, Staff. Prerequisite: permission of instructor. 2 or 4 cr.

### 877 (877). SUPERVISED TEACHING FOR GRADUATE STUDENTS

Planning and presenting classroom and laboratory material. Bi-weekly 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. Prerequisite: permission of instructor. 1 cr. NLG.

### 895-896. RESEARCH IN PLANT SCIENCE

Advanced investigations in a research subject, exclusive of thesis. Staff. 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. Staff. 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

**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, Lawrence W. O'Connell, Frederic W. Wurzburg

**ASSISTANT PROFESSORS:** Robert E. Craig, David W. Moore, B. Thomas Trout, Susan O. White

A candidate for admission to graduate study in the Department of Political Science normally is 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, a candidate may be admitted provided that s/he follows without credit a program of study approved by the chairperson. In all cases the Graduate Record Exam 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 four credits), for a total of 36 credits. Of the eight courses, one must be Political Science 893, Contemporary Political Analysis; and the second, 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

## Political Science

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outside the department. Where a candidate lacks proficiency in tools of quantitative analysis or a foreign language essential to his program of study and research, she/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 two shall be chosen from the courses and seminars in public administration offered by the department, and three from other Political Science courses according to the needs and interests of the candidate. Normally, one course shall be in statistics (Resource Economics 701 is recommended but other statistics offerings may fill this requirement with approval of the program adviser). Those candidates who have successfully completed comparable undergraduate work in statistics may be exempted from this requirement. The remaining two courses shall be chosen from outside the department in related fields such as economics, administration, resource economics, sociology, and recreation and parks.

Candidates for advanced degrees are expected to take courses at the 800-level in political science, and to maintain a passing grade (B-) in all courses.

Required courses and an appropriate range of electives are offered every year.

### Political Thought

#### 700/800. POLITICAL THOUGHT AND CULTURE

Relation between man's artistic and social endeavors and forms, and his political thought. Study of politics and literature through figures such as Aristophanes, Swift, Shakespeare, and contemporary writers. 4 cr.

#### 701/801. THE SCIENTIFIC STUDY OF POLITICS: ITS PHILOSOPHICAL DEVELOPMENT

Formulations and criticisms of the scientific study of politics beginning with Aristotle, and reviewing the development of modern scientific method from Bacon to the present. 4 cr. (Alternate years.)

**702/802. IDEOLOGIES AND DISSENT IN AMERICA AND THE WEST**  
Ideas and movements of protest since the late 19th century, particularly attacks upon liberal democratic theory and practice. 4 cr. (Alternate years.)

**797, 798/897, 898. SECTION 1: SEMINAR IN POLITICAL THOUGHT**  
Advanced treatment and individual research. Prerequisite: senior or graduate standing. 4 cr.

### Scope and Methods

#### 793/893. CONTEMPORARY POLITICAL ANALYSIS

Various forms of contemporary political analysis, with attention both to methods of empirical inquiry and explanation and to modes of justification. Intended for advanced students; normally open to seniors and graduate students only. 4 cr.

#### 820. METHODS OF RESEARCH IN POLITICAL BEHAVIOR

Methodology and techniques in evaluating political behavior; surveys, experimental designs, and basic data processing. Aspects of computer technology and political research. 4 cr.

### American Politics

#### 730/830. ADMINISTRATIVE PROCESS

Principle concepts of administrative behavior and public bureaucracy. 4 cr.

#### 731/831. URBAN AND METROPOLITAN POLITICS

Planning and management of the urban community. Intergovernmental relations, administrative functions, and general urban problems. 4 cr.

#### 732/832. PSYCHOLOGY OF POLITICAL BEHAVIOR

Cultural, social, economic, and emotional forces influencing the citizen's political activity. 4 cr.

#### 733/833. INTERGOVERNMENTAL RELATIONS AND FEDERALISM

Interrelationship of national, state, and local governments in the American federal system. Patterns of regionalism, interstate cooperation and conflict, and the evolution of federal relations. 4 cr.

#### 735/835. AMERICAN PLURALISM

Focus on a particular problem in American politics, such as the role of private power, interest groups, participation and representation, civil liberties, and political freedom. 4 cr. (Alternate years.)

797,798/897, 898. SECTION (2): SEMINAR IN AMERICAN POLITICS  
4 cr.

797, 798/897, 898. SECTION (6): SEMINAR IN PUBLIC  
ADMINISTRATION  
Advanced analysis and individual research including opportunities for  
direct observation of governmental administration. 4 cr.

### Comparative Politics (A. Area Studies)

750/850. POLITICS IN WEST EUROPE  
Aspects of the politics of the major continental powers. 4 cr. (Alternate  
years.)

751/851. MAJOR COMMONWEALTH STATES: BRITAIN, CANADA,  
AUSTRALIA  
Comparison and analysis of major governments influenced by the  
British parliamentary system; federal systems and ethnic diversity as  
exemplified by French Canada. 4 cr. (Alternate years.)

752/852. POLITICS IN THE USSR AND EAST EUROPE  
Comparative analysis of the background, structure, and underlying  
issues of political systems. Ideological bases, political history, and con-  
temporary trends. 4 cr.

753/853. MAJOR GOVERNMENTS OF EAST ASIA: CHINA AND JAPAN  
Political development within the historical context; related economic,  
social, and cultural variables. Comparative perspective where appro-  
priate. 4 cr.

755/855. GOVERNMENT AND POLITICS IN SOUTHEAST ASIA  
4 cr. (Alternate years.)

797, 798/897, 898. SECTION 3: SEMINAR IN COMPARATIVE  
POLITICS OF NATIONS  
Includes advanced analysis and individual research on national or  
regional politics. Prerequisite: senior or graduate standing. 4 cr.

### Comparative Politics (B. Problems in Comparative Politics and Development)

757/857. POLITICAL DEVELOPMENT AND POLITICAL DECAY  
Issues and concepts of political change. 4 cr. (Alternate years.)

758/858. COMPARATIVE JUDICIAL PROCESSES  
Court systems and their relationships to political life; political, social,  
and structural influences on judicial behavior; law and human be-  
havior. 4 cr. (Alternate years.)

759/859. COMPARATIVE LEGISLATIVE BEHAVIOR  
Role, organization, operation, and conduct of legislatures in national  
political systems. 4 cr. (Alternate years.)

760/860. COMPARATIVE COMMUNIST SYSTEMS  
Interest groupings, elites, and decision-making; political behavior  
within communist international organizations; intraparty distinctions  
between ruling and non-ruling communist parties. 4 cr. (Alternate  
years.)

761/861. POLITICAL SOCIOLOGY  
Impact of social structure and change upon political behavior, including  
elite/mass relationships, integration and instability. Major empirical  
findings and theoretical contributions, from Marx and Weber to the  
present. 4 cr. (Alternate years.)

797, 798/897, 898. SECTION 4: SEMINAR IN COMPARATIVE  
POLITICS  
Includes advanced analysis and individual research. Administration,  
foreign policy, political parties, and governmental institutions. Prere-  
quisite: senior or graduate standing. 4 cr. (Alternate years.)

### International Politics

775/875. THEORIES OF INTERNATIONAL POLITICS AND  
INTEGRATION  
General explanations for the behavior of nations and of the theory and  
practice of supra-national integration. Theories of peace and security  
and community building at the international level. Concepts and prac-  
tices of arms limitation and conflict resolution. 4 cr. (Alternate years.)

776/876. STRATEGY AND NATIONAL SECURITY POLICY  
Defense and deterrence among the major powers; impact of modern  
weapons on war and arms limitation. Armed forces role in shaping  
defense policy. 4 cr.

777/877. INTERNATIONAL LAW  
Formalized processes for regularizing state behavior; development of  
norms based on custom, precedent, and formal institutions, as in treaties  
and cases. Arms reduction and limitation arrangements; inspection; and  
other formal procedures designed to preserve peace. 4 cr. (Alternate  
years.)

### **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. (Alternate years.)

### **779/879. FOREIGN POLICIES IN EUROPE**

East-West relations, security alliances, economic and political cooperation, and the impact of domestic change and superpower relationships on international politics in Europe. 4 cr. (Alternate years.)

### **780/880. FOREIGN POLICIES OF THE USSR AND THE SOVIET BLOC**

Foreign policy and strategy in its national and European coalition context; Soviet-American and Sino-Soviet relations. 4 cr.

### **781/881. INTERNATIONAL POLITICS OF EAST ASIA**

Foreign and defense policies emphasizing Japan, China, and selected Southeast Asian nations, including their efforts at cooperation. 4 cr.

### **797, 798/897, 898. SECTION 5: SEMINAR IN INTERNATIONAL POLITICS**

Advanced analysis and individual research; emphasis on developments in theory. Prerequisite: senior or graduate standing. 4 cr.

### **899. SECTION 1: DIRECTED RESEARCH AND STUDY**

4 cr.

### **899. SECTION 2: MASTER'S THESIS**

4 cr.

## **Related Courses in Recreation and Parks**

### **870. ADMINISTRATIVE INTERNSHIP**

Practical administrative experience in an area of professional interest. Prerequisites: MPA candidate—specialization in recreation and parks and permission of instructor. 4 cr. Cr./F.

### **885. COMPREHENSIVE PLANNING**

Leisure and tourist planning—local, county, and regional. Recreation programming and resource development. Legislative aspects, court decisions, administrative organization, zoning, land use, and other master planning considerations. Prerequisite: permission of instructor. 4 cr.

### **890. SPECIAL TOPICS AND PROJECTS**

Advanced study in specific areas; may involve formal classes, seminars, or independent projects. Prerequisite: permission of instructor. 4 cr.

## Psychology

**Chairperson:** Ronald E. Shor

**PROFESSORS:** Raymond L. Erickson, Eugene S. Mills, John A. Nevin, Ronald E. Shor.

**ASSOCIATE PROFESSORS:** Lance K. Canon, Robert G. Congdon, Rand B. Evans, Peter S. Fernald, G. Alfred Forsyth, Earl C. Hagstrom, Daniel C. Williams.

**ASSISTANT PROFESSORS:** Gregory J. Bertsch, James R. Davis, E. Allan Lind, John E. Limber, David I. Schickedanz, Marty J. Schmidt, Stephen J. Weber, William R. Woodward.

## Doctor of Philosophy

The Department of Psychology offers a four-year program of study leading to the Doctor of Philosophy degree. The basic goal of the program is the development of behavioral scientists who can both carry out sound research in an area of specialization and teach effectively. Integral to the program is the development of specific skills required by the research psychologist who intends to become a college or university teacher. In order to develop these skills, each year the program required of all students includes a variety of research and instructional activities in addition to the usual academic work. In the 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 student to plan an effective graduate program. Core courses taken by all students include methodology, statistics, and the seminar and practicum in the teaching of psychology. Work outside the department also is included in each student's program. Depth in a particular area is obtained through participation in 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 language requirements and the qualifying examination for advancement to candidacy for the Ph.D. degree 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 aptitude 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, experimental psychology, learning theory, and systematic 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 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. Graduate credit for a 700-series course is permitted only with the previous approval of the student's adviser.

The graduate courses are offered in a two year cycle. All basic courses are offered each year and special courses and seminars are offered every other year. 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. No 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 non-parametric 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. Prerequisites: 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.

#### 808. MEASUREMENT AND ASSESSMENT

The nature of measurement in psychology including the techniques for evaluating various assessment procedures and to the theory of data. Prerequisite: Psych 807. 3 cr.

#### 812. PSYCHOLINGUISTICS

The use and development of human language: the nature of explanation, contemporary linguistic theory, semantics, functions of language, 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 are among the topics examined in depth. 3 cr.

#### 815. PSYCHOLOGY OF PERCEPTION

An information-processing approach to perception is taken. A study is made of the development of perceptual theory and its relationship to current perceptual research. Research and theory are examined as they pertain to issues such as: the definition of the stimulus, selective attention in perception, active vs. passive perception, the interactions between sense modalities in information-process, the development of perception in the individual, methodologies and problems of measurement in perception, the role of adaptation in perception, parallel vs. serial processing of information, the role of peripheral and central mechanisms in perception, and the relationship of perception to other content areas in psychology. Opportunities are given for designing and running perception experiments. 3 cr.

#### 816. INFORMATION FEEDBACK AND DECISION MAKING

A seminar devoted to the study of the roles of uncertainty and preference in purposive behavior. 3 cr.

#### 817. SENSORY AND PERCEPTUAL PROCESSES

An introduction to the sensory psychology of visual and auditory perception. The course is intended to acquaint the student with the major problems of current interest in sensory psychology and provide basic skills necessary to begin sensory-perceptual research. Major topic

# Psychology

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areas: 1) Physics of visual and auditory stimuli; 2) Sensory physiology of visual and auditory systems; 3) Basic visual 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**

A study of the research methods and current concepts in the neurosciences. 3 cr.

## **832. PHYSIOLOGICAL PSYCHOLOGY II**

A continuation of Psych 831. 3 cr.

## **833. ADVANCED PHYSIOLOGICAL PSYCHOLOGY**

Devoted to an intensive examination of a specific topic in the neurosciences. Topics vary depending upon interests of instructor and students. Prerequisite: Psych 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.

## **842. STIMULUS CONTROL**

Current research and theory dealing with the control of learned behavior by antecedent and current environmental stimuli. Prerequisite: Psych 841 or equivalent. 3 cr.

## **843. INSTRUMENTAL CONDITIONING AND AVERSIVE CONTROL**

The course examines in depth the theoretical and methodological problems encountered in the study of the acquisition and extinction of instrumental behavior. Topics include: reinforcement theory, partial reinforcement, punishment, escape, avoidance, and biological constraints on conditioning. Each student will choose and prepare a review of the literature on a topic for written and oral presentation. Prerequisite: Psych 841 or equivalent. 3 cr.

## **844. SEMINAR IN HUMAN LEARNING**

Offered irregularly as student and faculty interests require. Prerequisite: Psych 841 or equivalent. 3 cr.

## **850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**

An examination of procedures, logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Issues regularly introduced include experimental, quasi-experimental, and non-experimental designs, the laboratory-field continuum, social

psychological aspects of interviews and experiments, the nature of artifacts, and other current methodological issues. The course emphasizes the design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Prerequisites: Psych 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**

An in-depth study of various approaches to attitudinal and attributional processes with particular emphasis upon current theoretical issues. Prerequisite: Psych 851. 3 cr.

## **853. GROUP PROCESS AND SOCIAL INFLUENCE**

An examination of the problems of the individual in the group and the group as a system with special emphasis on aspects of social influence. Prerequisite: Psych 851 or permission of instructor. 3 cr.

## **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 non-verbal communication, ethnic and racial prejudice, and environmental psychology. May be repeated for credit. Prerequisite: Psych 851. 3 cr.

## **856. PSYCHOLOGY OF PERSONALITY**

Analysis of major theories and research in personality. 3 cr.

## **871. SURVEY OF THE HISTORY OF PSYCHOLOGY**

A general overview of the history of psychology from its beginnings to the end of the era of schools, ca. 1935. 3 cr.

## **872. METHODS AND THEORIES IN HISTORICAL RESEARCH ON THE BEHAVIORAL SCIENCES**

A survey of the main theories and methods employed in historical research with particular emphasis on those most directly applicable to the study of the behavioral sciences. Prerequisite: Psych 871 or permission of the instructor. 3 cr.

**873. SYSTEMS, SCHOOLS, AND SCIENTIFIC EXPLANATION**

An analysis of the principle schools of psychological thought viewed within the context of the philosophy of science. Prerequisite: Psych 871 or permission of the instructor. 3 cr.

**874. PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY**

In-depth studies of particular individuals, movements, and subfields. Topics vary and students in the history of psychology program are expected to take the course more than once. Prerequisites: Psych 871, 872, or permission of instructor. 3 cr.

**875. ARCHIVAL RESEARCH AND THE MANAGEMENT OF MANUSCRIPT COLLECTIONS**

A survey of the basic techniques of archival research including ethical and legal considerations. Training will be given in the organization and management of a small manuscript collection. Laboratory experience will be included. Prerequisites: Psych 871, 872, or permission of instructor. 3 cr.

**876. TOPICS AND METHODS IN THE HISTORIOGRAPHY OF PSYCHOLOGY**

Quantitative methods of mapping psychology as a science on individual, instructional, and international levels, e.g. growth indicators, content analyses. The extension of psychological principles into the history of science will also be discussed. May be repeated. Prerequisites: Psych 871, 872, or permission. 3 cr.

**881. SEMINAR IN DEVELOPMENTAL PSYCHOLOGY**

Devoted to topics of current interest in developmental psychology. Core material will be followed by in-depth study in an area of student's interest. 3 cr.

**891-892. PRACTICUM AND SEMINAR IN THE TEACHING OF PSYCHOLOGY**

Practicum offers the student an opportunity to teach introductory psychology under close supervision from the staff. The seminar is coordinated with this experience and focuses on both practical and theoretical issues of significance in the teaching/learning process at the college level. Required of all doctoral students, typically during the third year. 5 cr.

**894. ADVANCED RESEARCH IN PSYCHOLOGY**

Each student will design and conduct original research that culminates in a paper of publishable quality. Completion of either this course or Psych 899 will satisfy the department's research requirement for the master's degree. Staff. 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. 1) Physiological, 2) Perception, 3) History and Theory, 4) Learning, 5) Social, 6) Cognition, 7) Statistics and Methodology, 8) Psychopathology, 9) Developmental. 3-6 cr. per semester.

**897-898. PROBLEMS AND ISSUES IN PSYCHOLOGY**

Offered occasionally, the seminar will feature a problem which has been the subject of specialized research and study by a member of the staff. The personnel and topical focus will vary from year to year, and the course may be repeated by the student. 3 cr.

**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**

**822. THERAPEUTIC PSYCHOLOGY**

The course will orient itself around the following three areas: issues which include various aspects of the human condition, essential ingredients in the therapeutic process and in therapy outcomes, effective qualities of therapists, and a full range of ethical considerations; involvement through participation in a group for the presentation of a particular therapeutic approach, comparison of two or more therapists or kinds of therapy, or application of therapeutic psychology to a particular problem area of institutional setting; integration of personal reading, participation in class discussions, and comparison of group presentations. 4 cr. (Offered only in the summer.)

**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. Prerequisite: permission of instructor. (Student's background in statistics, measurement, exceptional child, and personality theory will be evaluated by the instructor.) 1 lec/1 lab/4 cr. to be granted only after the student has passed the companion course, Psych 825.

## Sociology

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### 824. PRACTICUM IN INDIVIDUAL INTELLIGENCE TESTING

Supervised experience in use of individual intelligence tests in elementary and junior high school settings. Prerequisites: Psych 823 or equivalent, and permission of instructor. 2 cr. to be granted only after the student has passed Psych 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. Emphasis will be on taking into account background factors such as culture, emotional status, meaning of the test to the child, and on 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. Prerequisites: Psych 823, Psych 824, which may be taken concurrently; permission of the instructor. 4 cr.

## Sociology

**Chairperson:** Richard E. Downs

**PROFESSORS:** Melvin T. Bobick, Walter Buckley, Richard S. Dewey, Stuart Palmer, Solomon Poll, Murray Straus.

**ASSOCIATE PROFESSORS:** Thomas R. Burns, Peter Dodge, Richard E. Downs, Bud B. Khleif, Arnold S. Linsky, Fred Samuels, Howard M. Shapiro

**ASSISTANT PROFESSORS:** Charles Bolian, Loren Cobb, Stephen P. Reyna  
**DIRECTOR OF GRADUATE STUDIES:** Arnold S. Linsky

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, students may propose to the graduate committee other major areas of specialization which fall 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 extra-departmental 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 course work 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 the 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 (which would normally be 803); 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 verbal and quantitative sections of the aptitude test and his/her score 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.

Ordinarily, students will be admitted in the expectation of their completing the entire graduate program. Well-qualified applicants for a terminal Master of Arts degree, and applicants who have initiated their graduate work in sociology at another institution, will, however, be given full consideration.

#### **720. CURRENT DEVELOPMENTS IN SOCIOLOGY OF THE FAMILY**

A current topic will be selected each semester, such as stratification and the family, intra-family 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. Prerequisite: 8 credits of sociology, Soc 520 recommended. 4 cr.

#### **721. FAMILY INTERACTION**

Influence of family interaction on human behavior. Self, interactionist, and role approach. Analysis of research. Prerequisite: 8 credits of sociology and/or psychology; Soc 500 recommended. 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. Prerequisite: permission of instructor. 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. Prerequisite: Soc 400. 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. Prerequisite: permission of instructor. 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. Prerequisite: Soc 400. 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. Prerequisite: permission of instructor. 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. Prerequisite: prior courses in sociology, anthropology, or psychology. 4 cr.

## Sociology

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### 780. SOCIAL CONFLICT

The nature of social conflict, especially at war. The setting and initiation of conflict, its dynamics, and the factors affecting its course and outcome. Prerequisite: permission of instructor. 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. Prerequisite for graduate students: permission of instructor. 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. Prerequisite: Soc 601. 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. Prerequisite: Soc 602, Statistics, or permission of instructor. 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. Prerequisite: Soc 601, Methods of Social Research and 602, Social Statistics, or their equivalent, or permission of instructor. 4 cr.

### 803. SOCIOLOGICAL METHODS III. SPECIAL PROBLEMS IN METHODS AND STATISTICS

The focus of this course is alternated between special problems in sociological research such as measurement, multi-variate analysis and field methods. Prerequisite: Soc 801 and 802 or Psych 809. 4 cr.

### 811. SOCIOLOGICAL THEORY I

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prerequisites: Soc 611, History of Social Theory, and 612, Contemporary Sociological Theory, or their equivalents. 4 cr.

### 812. SOCIOLOGICAL THEORY II

The content, presuppositions, and implications of contemporary sociological theory. The student will engage in theory construction and analysis, and in this endeavor will be encouraged to develop his/her particular interests in substantive areas. Prerequisite: Soc 811. 4 cr.

### 813. SOCIOLOGICAL THEORY III

A seminar of intensive study of topics in sociological theory. Sample topics include: exchange theory, functionalism, systems theory, theory construction, pioneering theorists. Prerequisites: Soc 611, History of Social Theory, and 612, 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. Prerequisite: permission of instructor. 4 cr.

### 830. THE SMALL GROUP

Sociological and social psychological perspectives on interaction within small groups. Prerequisite: courses in sociology and social psychology, or permission of instructor. 4 cr. (Alternate years; offered 1976-77.)

### 838. 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 Ed 838.)

### 850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS

An examination of the logic, inferential strength, and potential bias of the various methodologies for studying social behavior. Issues include experimental and non-experimental 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. (Also offered as Psych 850.) 4 cr.

### 852. SOCIALIZATION AND ABNORMAL BEHAVIOR

A survey of those orientations that relate socialization to abnormal behavior and synthesizing the major concepts into current sociological and social psychological frame of reference. Prerequisite: at least one course in social psychology or permission of instructor. 4 cr.

**854. SOCIOLOGY OF RELIGION**

Critical analysis of 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. Prerequisite: Soc 761 or permission of instructor. 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. Prerequisites: Soc 601 and 602. 4 cr.

**875. FAMILY AND BEHAVIOR PROBLEMS**

Analysis of the approaches used in the sociological study of families. Emphasis on the distinct contributions and the overlaps among such approaches as social structure and socialization. Theoretical statements and empirical studies utilizing these approaches will be discussed. Specific focus will be directed to the use of various models, conceptualizations, etc., for research on families with behavior problems (broadly defined). Issues concerning familial etiology of the response to behavior problems as well as the family's transactions with the wider community will be dealt with in reference to particular types of problems. 4 cr.

**885. OCCUPATIONS AND PROFESSIONS**

Professionalization as adult socialization, an acquisition of a new identity. Professions as ideologies, markets, and extended families. Research perspective of the Chicago School of Sociology. 4 cr.

**888. SOCIOLOGY OF EDUCATION: THE CULTURES OF POVERTY AND AFFLUENCE**

The schooling of "culturally deprived" and "culturally endowed" pupils. Problems of social and geographic mobility and immobility. Rise of the counseling and healing trades. 4 cr. (Also offered as Ed 888.)

**889. SOCIOLOGY OF EDUCATION: RACE AND ETHNIC RELATIONS IN SCHOOLS AND SOCIETY**

Ethnic stratification inside and outside the school. The schooling of Whites and non-Whites. Issues of bilingualism, culture and identity. (Also offered as Ed 889.)

**895, 896. READING AND RESEARCH IN SOCIOLOGY AND ANTHROPOLOGY**

A student prepared by training and experience to do independent work under the guidance of an instructor may register for one or more of the following sections: 1) communications, 2) criminology, 3) cultural/social anthropology, 4) culture change, 5) culture and personality, 6) deviant behavior, 7) prehistoric archaeology, 8) family, 9) population, 10) rural-urban, 11) social control, 12) social differentiation, 13) social movements, 14) social psychology, 15) social research, 16) social theory, 17) anthropological linguistics, 18) social welfare. Prerequisites: 16 graduate hours of sociology and permission of instructor. Hours and credit to be arranged.

**897, 898. SPECIAL TOPICS SEMINAR**

Under the direction of members of the department on the basis of rotation and interest, seminars are offered in those fields listed under Soc 895, 896. Prerequisite: permission of instructor. 4 cr.

**899. MASTER' THESIS**

Usually 6 cr. but up to 10 cr. when the problem warrants.

**999. DOCTORAL RESEARCH****Anthropology****731, 732. AREA STUDIES IN ARCHAEOLOGY**

Offered as staff is available and student needs dictate. 1) South America: from earliest cultural remains to European contact; changing relationship of culture and environment emphasized. 2) Mesoamerica: earliest cultural remains through Olmec, Maya, Toltec and Aztec; changing relationship of culture and environment emphasized. Prerequisite: Anthro 412 and 514, or permission of instructor. 4 cr.

**747 (747). AREA STUDIES IN SOCIAL AND CULTURAL ANTHROPOLOGY**

1) South America, 2) Meso America, 3) North America, 4) Oceania, 5) Southeast Asia, 6) Africa, 7) Other. Offered as staff is available and the student needs dictate. Characteristic ecological, historical, and socio-cultural factors. Analysis of selected societies and institutions. Prerequisite: Anthro 411 or permission of instructor. 4 cr.

**752. SOCIAL PROBLEMS IN MODERN AFRICA**

Problems of change and development in Africa considered from the anthropological perspective. Prerequisite: Anthro 411 or permission of instructor. 4 cr.

## Spanish

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### 775. ANTHROPOLOGICAL THEORY

Major theoretical approaches in historical perspective. Prerequisite: Anthro 411 or permission of instructor. 4 cr.

## Spanish

**Chairperson:** John C. Rouman, Associate Professor of Classics

**PROFESSORS:** R. Alberto Casás, Charles H. Leighton

**ASSOCIATE PROFESSOR:** Richard J. Callan

**ASSISTANT PROFESSORS:** F. William Forbes, Assistant Chairperson for Spanish, Lois Grossman

The Department of Spanish 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 she/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 department. 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, he/she 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 Spanish section chairperson.

## Spanish

### 801. BIBLIOGRAPHY AND METHODS OF RESEARCH

Required of all graduate students in their first year of study. An introduction to standard bibliographical techniques, 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. 1 cr. May be repeated for a sum total of 3 cr.

### 811. MEDIEVAL SPANISH LITERATURE

Spanish literature including social and historical backgrounds, 1100-1500: *The Poema de mio Cid*, Berceo, *The mester de clerecia*, *The Libro de buen amor*, *The 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.)

### 852. DRAMA AND POETRY OF THE SIGLO DE ORO

Social and historical background of Baroque period. Representative plays of Lope de Vega, Tirso de Molina, Calderón; lyric poetry of Lope, Góngora, and Quevedo; prose developments. 3 cr. (Not offered every year.)



**854. CERVANTES**

Cervantes' 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 Galdos, and Blasco Ibáñez. Romanticism, realism, and naturalism. 3 cr. (Not offered every year.)

**857. THEATER AND POETRY OF THE 20th CENTURY**

The Generation of 1898 and *Modernismo*: Lorca, Casona, Buero Vallejo, Sastre, Salinas, Guillén, and Miguel Hernández. 3 cr.

**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, micro-teaching of the language skills. Prerequisite: permission of instructor. 3 cr.

**895-896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE**

1) The history of the Spanish language, 2) Medieval Spanish literature, 3) Spanish literature of the Renaissance, 4) Spanish literature of the Golden Age, 5) Spanish literature of the 18th and 19th centuries, 6) Spanish literature of the 20th century (1898-1936), 7) Contemporary Spanish literature, 8) Spanish American literature of the 16th and 17th centuries, 9) Spanish American literature of the 18th and 19th centuries, 10) Spanish American literature of the 20th century, 11) Contemporary Spanish American literature, 12) Structural and applied linguistics, 13) Spanish Literary Criticism, 14) Spanish-American Essay, 15) Latin America, 16) Catalan, 17) Spanish-American Poetry, 18) Spanish Poetry, 19) Galdos, 20) Archetype Latin American literature, 21) Special Teaching Problems, 22) Spanish Civilization and Culture, 23) Latin-American Civilization and Culture, 24) Borges, 25) Spanish Theater. Guided study with training in bibliography and organization of material. Topics selected by instructor and student in conference. Prerequisite: permission of major supervisor. Variable, 1-3 cr.

**899. MASTER'S THESIS**

6 cr.

**Zoology**

**Chairperson:** Philip J. Sawyer

**PROFESSORS:** Arthur C. Borrer, Wilbur L. Bullock, Lorus J. Milne, Philip J. Sawyer, Emery F. Swan, Paul A. Wright

**ASSOCIATE PROFESSORS:** Robert A. Croker, John E. Foret, Larry G. Harris, Frank K. Hoornbeek, Marcel E. Lavoie, John J. Sasner, Edward K. Tillinghast

**ADJUNCT ASSOCIATE PROFESSOR:** Clarence Porter

**ASSISTANT PROFESSORS:** Edward N. Franco, James F. Haney, Roderick M. Smith, Ellsworth H. Wheeler

The graduate program in zoology is intended for the student who aspires 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, genetics, invertebrate zoology, mammalogy, biological oceanography, parasitology, and physiology.

To be admitted to graduate study in zoology, a student 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, 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.

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 (Zoology 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 doctoral 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. Prerequisite: 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 corequisite: Zoo 604 or equivalent and permission of instructor. 2 cr.

### **(707). HUMAN GENETICS**

Inheritance patterns; gene and chromosome mutation rates and effects; linkage and gene frequency. Prerequisite: Zoo 604 or equivalent 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. Prerequisite: general zoology and Zoo 518. 4 cr.

### **(712). MAMMALOGY**

Origins, diversification, reproduction, ecology, behavior of mammals. Identification of local forms. Prerequisites: Zoo 412, 518. 4 cr.

### **(713). ANIMAL BEHAVIOR**

Individual and social behavior. The role of anatomy, physiology, ecology, and prior experience. Techniques and practical application. Prerequisite: 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. Prerequisite: general zoology. Summer only. 4 cr.

## 717. GENERAL LIMNOLOGY

Special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prerequisite: Bio 541 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. Prerequisite: present or prior enrollment in Bot 717, Zoo 717, or equivalent; and permission of instructor. 3 cr.

## 721. PARASITOLOGY

Introduction to the more important parasites causing disease in man and animals. Living materials will be used as far as possible. Prerequisite: one year of zoology. 4 cr. (Alternate years: offered in 1976-77.)

## 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. Prerequisite: organic chemistry. 4 cr.

## 724. MARINE PARASITOLOGY

Diseases and parasites of marine fishes and shellfish; emphasis on the local estuarine environment. Prerequisite: one year of zoology. 4 cr. (Alternate years: offered in 1977-78.)

## 728. INVERTEBRATE EMBRYOLOGY

Principles of animal development including metamorphosis and regeneration. Representative invertebrate types. Prerequisite: Zoo 618. 3 lec/1 lab/4 cr.

## 729. VERTEBRATE EMBRYOLOGY

Principles of animal development; metamorphosis, regeneration, and aging. Selected vertebrates. Prerequisites: Zoo 518, 527, and 604. 3 lec/1 lab/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. Prerequisite: Zoo 508 or 518 or equivalent. 1-hr lec/6-hr lab/4 cr.

## 732. SOIL ZOOLOGY

Faunal communities of terrestrial soils, their ecology and natural history. Effects of animal activities on soil processes and composition. Collection, extraction, and study methods. Independent projects. Prerequisite: Bio 541. 4 cr. (Alternate years: offered in 1976-77.)

## 772. FISHERIES BIOLOGY

Information and techniques used by fisheries biologists. Emphasis on fish life history, ecology, and economics as related to management techniques. Prerequisite: Zoo 711 or equivalent, and permission of instructor. 4 cr.

## 774. INTRODUCTION TO MARINE SCIENCE

Daily lectures; laboratory, and field work. Offered at the Isles of Shoals in cooperation with Cornell and the State University of New York. Summers only. Prerequisite: at least a full year of college biology. 5 cr.

## 795, 796. SPECIAL PROBLEMS IN ZOOLOGY

1) Biological Oceanography, 2) Ecology, 3) Endocrinology, 4) Evolution, 5) Developmental Biology, 6) Genetics, 7) Histology, 8) History of Zoology, 9) Invertebrate Zoology, 10) Physiology, 11) Vertebrate Zoology, 12) Zoogeography, 13) Zoological Techniques, 14) Parasitology, 15) Histochemistry, 16) Protozoology, 17) Systematics, 18) Animal Behavior, 19) Teaching Practices. May elect one or more sections for advanced study. Reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of staff required. (Limit of 12 credits from the sections of this course.) 2 or 4 cr.

## (803). MARINE ECOLOGY

Marine environment and its biota, emphasizing intertidal and estuarine habitats. Includes field, laboratory, and independent research project. Prerequisites: General Ecology and permission of instructor; marine invertebrate zoology, oceanography and statistics are desirable. Mr. Croker. 4 cr. (Alternate years: offered in 1975-76.)

## (806). BIOLOGICAL OCEANOGRAPHY

Ocean as an environment for life; oceanic populations, their interrelationships and adaptations. Prerequisite: permission of instructor. 4 cr. (not offered every year; offered 1976-77.)

### 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. Prerequisite: General Ecology and Limnology, Zoo 717, or equivalent, and permission of instructor. 4 cr. (Alternate years: offered in 1976-77.)

### 815. POPULATION ECOLOGY

Evolution, genetic theory, differentiation, and functioning of animal populations. Prerequisite: permission of instructor. 4 cr. (Not offered every year; offered 1978-79.)

### 817. ZOOPLANKTON

Oceanic and estuarine populations: zoogeography, interrelationships, and adaptations to pelagic life. Prerequisites: Invertebrate Zoology and instructor's permission. 4 cr. (Not offered every year; offered 1977-78.)

### (820), (821). ADVANCED INVERTEBRATE ZOOLOGY

Morphology, phylogeny, and natural history of the major invertebrate phyla. Prerequisite: Introduction to Invertebrate Zoology or equivalent. 4 cr. (Alternate years: offered in 1976-77.)

### (822). PROTOZOOLOGY

General biology of protozoa; morphology, physiology, natural history, and economic importance. Prerequisite: Zoo 721 or 820 or permission of instructor. Mr. Borrer. 4 cr. (Alternate years: offered in 1976-77.)

### 826. COMPARATIVE PHYSIOLOGY

A study of the nutrition, metabolism, neural function, reproduction and homeostatic mechanisms of animals, especially invertebrates. Prerequisite: Zoo 723 and instructor's permission. Mr. Sasner. 4 cr. (Alternate years: offered 1975-76.)

### 828. EXPERIMENTAL EMBRYOLOGY

Cellular differentiation during embryonic development. Laboratory techniques in experimental morphogenesis. Prerequisite: Zoo 728 or 729 or equivalent. Mr. Foret. 4 cr. (Alternate years: offered in 1976-77.)

### 895, 896. ADVANCED STUDIES IN ZOOLOGY

Course sections for advanced work, individual or group seminar. May include reading, laboratory work, organized seminars, and conferences. Prerequisite: permission of department chairperson and staff concerned. (Sections are the same as those listed under Zoology 795, 796.) 2 or 4 cr.

### 897, 898. ZOOLOGY SEMINAR

Reports on recent zoological literature. Subject fields are those listed under Zoo 795, 796; not all areas available every semester. Required of graduate students in zoology. Staff. No cr.

### 899. MASTER'S THESIS

Prerequisite: 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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Engineering

**William W. Mautz, Ph.D.**  
Assistant Professor of Wildlife Ecology

# Faculty of the Graduate School

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**Ackerman, Margaret D.**

Assistant Professor of Education; Ph.D., University of Pennsylvania, 1971; appointed 1971.

**Adams, W. Thomas**

Assistant Professor of Forest Resources; Ph.D., University of California, 1974; appointed 1974.

**Allen, Fred E.**

Professor of Animal Sciences, Veterinarian; D.V.M., Ohio State University, 1936; appointed 1940.

**Allmendinger, E. Eugene**

Associate Professor of Naval Architecture; M.S., University of New Hampshire, 1950; appointed 1958.

**Amell, Alexander R.**

Professor of Chemistry; Ph.D., University of Wisconsin, 1950; appointed 1955.

**Amsden, Katherine**

Associate Professor of Physical Education; Ph.D., University of Southern California, 1967; appointed 1967.

**Andersen, Kenneth K.**

Professor of Chemistry; Ph.D., University of Minnesota, 1959; appointed 1960.

**Anderson, Franz E.**

Associate Professor of Geology; Ph.D., University of Washington, 1967; appointed 1967.

**Andrew, Michael D.**

Associate Professor of Education; Ed.D., Harvard University, 1969; appointed 1966.

**Andrews, Richard A.**

Professor of Resource Economics; Ph.D., University of Minnesota, 1959; appointed 1959.

**Annis, William H.**

Professor of Occupational Education; Ed.D., Cornell University, 1961; appointed 1962.

**Antonak, Richard F.**

Assistant Professor of Education; Ed.D., Temple University, 1975; appointed 1974.

**Antosiewicz, Rose T.**

Assistant Professor of Italian; Ph.D., University of California at Los Angeles, 1971; appointed 1970.

**Arnoldy, Roger L.**

Professor of Physics; Ph.D., University of Minnesota, 1962; appointed 1967.

**Ashley, Charles H.**

Associate Professor of Education; Ed.D., Boston University, 1969; appointed 1969.

**Baker, Alan L.**

Assistant Professor of Botany; Ph.D., University of Minnesota, 1973; appointed 1972.

**Ballig, L.C.**

Professor of Physics; Ph.D., Harvard University, 1965; appointed 1967.

**Balomenos, Richard H.**

Professor of Mathematics Education; Ed.D., Harvard University, 1961; appointed 1961.

**Barlow, Robert F.**

Professor of Economics and Administration; Ph.D., Fletcher School of Law and Diplomacy, Tufts University, 1960; appointed 1962.

**Barrett, James P.**

Professor of Forest Biometrics and Genetics; Ph.D., Duke University, 1962; appointed 1967.

**Batchelder, Gerald M.**

Thompson School Associate Professor of Civil Technology and Adjunct Associate Professor of Civil Engineering; M.S.C.E., Purdue University, 1952; appointed 1953.

**Batho, Edward H.**

Professor of Mathematics; Ph.D., University of Wisconsin, 1955; appointed 1960.

**Beasley, Wayne M.**

Associate Professor of Materials Science; S.M., Massachusetts Institute of Technology, 1965; appointed 1957.

**Bechtell, Homer F., Jr.**

Associate Professor of Mathematics; Ph.D., University of Wisconsin, 1963; appointed 1966.

**Beckett, John A.**

Forbes Professor of Management; M.B.A., Harvard University, 1946; C.P.A.; appointed 1962.

**Bennett, Albert B.**

Associate Professor of Mathematics; Ed.D., University of Michigan, 1966; appointed 1967.

**Bereit, Virginia F.**

Assistant Professor of Education; Ed.D., Columbia University, 1971; appointed 1973.

**Bergeron, R. Daniel**

Assistant Professor of Mathematics; Ph.D., Brown University, 1973; appointed 1974.

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**Blanchard, Fletcher A., Jr.**

Professor of Electrical Engineering; M.S., Lehigh University, 1950; appointed 1950.

**Blanchard, Robert O.**

Assistant Professor of Plant Pathology; Ph.D., University of Georgia, 1971; appointed 1972.

**Blickle, Robert L.**

Professor of Entomology; Ph.D., Ohio State University, 1942; appointed 1938-41, 1946.

**Bobick, Melvin T.**

Professor of Sociology; Ph.D., University of Illinois, 1958; appointed 1958.

**Bogle, Alfred Linn**

Associate Professor of Botany; Ph.D., University of Minnesota, 1968; appointed 1970.

**Bolian, Charles**

Assistant Professor of Anthropology; Ph.D., University of Illinois, 1975; appointed 1971.



**Bonnice, William E.**

Associate Professor of Mathematics; Ph.D., University of Washington, 1962; appointed 1962.

**Borrer, Arthur C.**

Professor of Zoology; Ph.D., Florida State University, 1961; appointed 1961.

**Bothner, Wallace A.**

Associate Professor of Geology; Ph.D., University of Wyoming, 1967; appointed 1967.

**Bowman, James S.**

Assistant Professor of Entomology; Ph.D., University of Wisconsin, 1958; appointed 1971.

**Bowring, James R.**

Professor of Resource Economics; Ph.D., Iowa State University, 1944; appointed 1948.

**Boy, Angelo V.**

Professor of Education; Ed.D., Boston University, 1960; appointed 1965.

**Boynton, Jason E.**

Associate Professor of Education; M.Ed., University of New Hampshire, 1952; appointed 1966.

**Braff, Allan J.**

Associate Professor of Economics and Business Administration; Ph.D., University of Wisconsin, 1959; appointed 1965.

**Briden, Earl F.**

Assistant Professor of English; Ph.D., Brown University, 1970; appointed 1970.

**Broderick, Dale G.**

Associate Professor of Business Administration; Ph.D., Columbia University, 1973; appointed 1974.

**Brown, Roger S.**

Assistant Professor of German; Ph.D., University of Kansas, 1971; appointed 1974.

**Brown, Wendell S.**

Assistant Professor of Earth Sciences; Ph.D., Massachusetts Institute of Technology, 1971; appointed 1974.

**Bruns, Paul E.**

Professor of Forest Resources; Ph.D., University of Washington, 1956; appointed 1958.

**Buckley, Walter F.**

Professor of Sociology; Ph.D., University of Wisconsin, 1958; appointed 1971.

**Bullock, Wilbur L.**

Professor of Zoology; Ph.D., University of Illinois, 1948; appointed 1948.

**Burns, Thomas R.**

Associate Professor of Sociology; Ph.D., Stanford University, 1969; appointed 1968.

**Burt, John**

Assistant Professor of Business Administration; Ph.D., Carnegie-Mellon University, 1969; appointed 1974.

**Burton, David M.**

Associate Professor of Mathematics; Ph.D., University of Rochester, 1961; appointed 1959.

**Byers, Gordon L.**

Professor of Soil and Water Science; M.S.A., Ontario Agricultural College, 1950; appointed 1956.

**Caldwell, S. Anthony**

Associate Professor of English; Ph.D., Harvard University, 1968; appointed 1957.

**Callan, Richard J.**

Associate Professor of Spanish; Ph.D., St. Louis University, 1965; appointed 1969.

**Cannon, Michael R.**

Assistant Professor of Electrical Engineering; Ph.D., Rensselaer Polytechnic Institute, 1970; appointed 1974.

**Canon, Lance K.**

Associate Professor of Psychology; Ph.D., Stanford University, 1965; appointed 1973.

**Carney, John J.**

Assistant Professor of Education; Ph.D., Syracuse University, 1973; appointed 1973.

**Carnicelli, Thomas A.**

Associate Professor of English; Ph.D., Harvard University, 1966; appointed 1967.

**Carroll, John E.**

Assistant Professor of Environmental Conservation; Ph.D., Michigan State University, 1974; appointed 1974.

**Carter, Gavin H.**

Associate Professor of Physical Education; Ph.D., University of Oregon, 1958; appointed 1965.

**Casás, R. Alberto**

Professor of Spanish; Ph.D., Columbia University, 1954; appointed 1952.

**Celikkol, Barbaros**

Assistant Professor of Mechanical Engineering; Ph.D., University of New Hampshire, 1972; appointed 1969.

**Chaltas, John G.**

Associate Professor of Education; Ed.D., Columbia University, 1957; appointed 1967.

**Chasteen, N. Dennis**

Associate Professor of Chemistry; Ph.D., University of Illinois, 1969; appointed 1972.

**Chesbro, William R.**

Professor of Microbiology; Ph.D., Illinois Institute of Technology, 1959, appointed 1959.

**Chupp, Edward L.**

Professor of Physics; Ph.D., University of California, 1954; appointed 1962.

**Cimolic, Peter**

Adjunct Associate Professor of Education; Ph.D., University of Missouri, 1970; appointed 1970.

**Clark, Charles E.**

Professor of History; Ph.D., Brown University, 1966; appointed 1967.

**Clark, David G.**

Associate Professor of Physics; Ph.D., Pennsylvania State College, 1947; appointed 1947.

**Clark, Ronald R.**

Professor of Electrical Engineering; Ph.D., Syracuse University, 1963; appointed 1957.

**Clee, Jan E.**

Dean of the Whittemore School of Business and Economics and Professor of Organizational Behavior; Ph.D., Case Institute, 1967; appointed 1967.

**Cobb, Loren**

Assistant Professor of Sociology; Ph.D., Cornell University, 1973; appointed 1972.

**Cohen, Allan R.**

Associate Professor of Business Administration; D.B.A., Harvard Graduate School of Business Administration, 1967; appointed 1967.

**Cole, Lawrence P.**

Assistant Professor of Economics; Ph.D., Purdue University, 1969; appointed 1966.

**Collins, Walter M.**

Professor of Animal Science and Genetics; Ph.D., Iowa State University, 1960; appointed 1951.

**Congdon, Robert G.**

Adjunct Professor of Psychology; Ed.D., Harvard University, 1961; appointed 1952.

**Copeland, Arthur H., Jr.**

Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1954; appointed 1968.

**Corbett, Alan C.**

Associate Professor of Animal Science; D.V.M., Michigan State College, 1940; appointed 1941.

**Corcoran, Ellen P.**

Assistant Professor of Education; Ph.D., New York University, 1972; appointed 1972.

**Corell, Robert W.**

Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1964; appointed 1964.

**Craig, Robert E.**

Assistant Professor of Political Science; Ph.D., University of North Carolina, 1971; appointed 1966.

**Croker, Robert A.**

Associate Professor of Zoology; Ph.D., Emory University, 1966; appointed 1966.

**Crowson, Lydia L.**

Assistant Professor of French; Ph.D., University of Wisconsin, 1972; appointed 1972.

**Daggett, Albert F.**

Professor of Chemistry; Ph.D., Columbia University, 1934; appointed 1928-31, 1935.

**Davis, James R.**

Assistant Professor of Psychology; Ph.D., University of Wisconsin, 1969; appointed 1970.

**Davis, Richard S.**

Dean of the College of Engineering and Physical Sciences and Professor of Materials Science; Ph.D., University of Toronto, 1954; appointed 1968.

**Dawson, Carl**

Associate Professor of English; Ph.D., Columbia University, 1966; appointed 1970.

**Dawson, Charles O.**

Professor of Civil Engineering; M.S., Ohio State University, 1940; appointed 1930.

**Dawson, John F.**

Associate Professor of Physics; Ph.D., Stanford University, 1963; appointed 1968.

**Deporte, Michael V.**

Associate Professor of English; Ph.D., Stanford University, 1966; appointed 1972.

**Desrosiers, Richard V.**

Assistant Professor of Classics; Ph.D., University of North Carolina, 1969; appointed 1965.

**Deville, Phillippe**

Assistant Professor of Economics; Ph.D., Stanford University, 1973; appointed 1973.

**DeVoto, Mark B.**

Associate Professor of Music; Ph.D., Princeton University, 1967; appointed 1968.

**Dewey, Richard S.**

Professor of Sociology; Ph.D., University of Wisconsin, 1946; appointed 1958.

**Diamonti, Michael C.**

Assistant Professor of Education; M.Ed., Rutgers University, 1970; appointed 1973.

**Diller, Ann L.**

Assistant Professor of Education; Ed.D., Harvard University, 1971; appointed 1973.

**Diller, Karl C.**

Associate Professor of English; Ph.D., Harvard University, 1967; appointed 1972.

**Dishman, Robert B.**

Professor of Political Science; Ph.D., Princeton University, 1948; appointed 1951.

**Dodge, Peter**

Associate Professor of Sociology; Ph.D., Harvard University, 1961; appointed 1964.

**Downs, Richard E.**

Associate Professor of Anthropology; Ph.D., University of Leiden, 1956; appointed 1962.

**Draves, David D.**

Associate Professor of Education; Ph.D., University of Wisconsin, 1957; appointed 1964.

**Drew, William H.**

Associate Dean of the Graduate School and Professor of Resource Economics; Ph.D., Vanderbilt University, 1961; appointed 1956.

**Dunlop, William R.**

Professor of Animal Science; D.V.M., V.S., Ontario Veterinary College, 1938; appointed 1950.

**Dunn, Gerald M.**

Professor of Plant Science and Genetics; Ph.D., Purdue University, 1951; appointed 1951.

**Durgin, Owen B.**

Professor of Resource Economics; M.A., University of New Hampshire, 1951; appointed 1951.

**Durnall, Edward J.**

Director of the Division of Continuing Education and Associate Professor of Education; Ed.D., Oregon State University, 1953; appointed 1966.

**Eder, Sidney C.**

Assistant Professor of Education; Ph.D., Arizona State University, 1971; appointed 1971.

**Ellis, David W.**

Vice Provost for Academic Affairs and Associate Professor of Chemistry; Ph.D., Massachusetts Institute of Technology, 1962; appointed 1962.

**Erickson, Raymond L.**

Dean of the Graduate School, Director of Research, and Professor of Psychology; Ph.D., University of California at Los Angeles, 1962; appointed 1963.

**Estes, George O.**

Associate Professor of Plant Science; Ph.D., Oregon State University, 1969; appointed 1969.

**Evans, Rand B.**

Associate Professor of Psychology; Ph.D., University of Texas, 1967; appointed 1972.

**Fairchild, Thomas P.**

Associate Professor of Animal Science and Genetics; Ph.D., University of Wisconsin, 1964; appointed 1969.

**Fan, Stephen S.T.**

Associate Professor of Chemical Engineering; Ph.D., Stanford University, 1962; appointed 1962.

**Fernald, Peter S.**

Associate Professor of Psychology; Ph.D., Purdue University, 1963; appointed 1966.

**Fink, Stephen L.**

Associate Dean of the Whittemore School of Business and Economics and Professor of Organizational Development; Ph.D., Case Western Reserve University, 1959; appointed 1969.

**Fisher, G. Thomas**

Associate Professor of Entomology; Ph.D., Rutgers University, 1954; appointed 1969.

**Forbes, F. William**

Assistant Professor of Spanish; Ph.D., University of Arizona, 1971; appointed 1970.

**Foret, John E.**

Associate Professor of Zoology; Ph.D., Princeton University, 1966; appointed 1967.

**Forsyth, G. Alfred**

Associate Professor of Psychology; Ph.D., Purdue University, 1967; appointed 1967.

**Fort, Marron C.**

Associate Professor of German; Ph.D., University of Pennsylvania, 1965; appointed 1969.

**Foster, Bennet B.**

Associate Professor of Forest Resources; Ph.D., Duke University, 1966; appointed 1969.

**Francq, Edward N.**

Assistant Professor of Zoology; Ph.D., Pennsylvania State University, 1967; appointed 1965.

**Frick, George E.**

Adjunct Professor of Resource Economics; M.S., University of Connecticut, 1947; appointed 1957.

**Frost, Albert D.**

Professor of Electrical Engineering; Sc.D., Massachusetts Institute of Technology, 1952; appointed 1957.

**Gadon, Herman**

Professor of Business Administration; Ph.D., Massachusetts Institute of Technology, 1957; appointed 1964.

**Gatteno, Samuel**

Assistant Professor of French; Ph.D., Columbia University, 1971; appointed 1975.

**Gaudette, Henri E.**

Associate Professor of Geology; Ph.D., University of Illinois, 1963; appointed 1965.

**Geeslin, William E.**

Assistant Professor of Mathematics; Ph.D., Stanford University, 1972; appointed 1972.

**Geoffrion, Leo D.**

Assistant Professor of Education; Ph.D., John Hopkins University, 1975; appointed 1975.

**Gerhard, Glen C.**

Associate Professor of Electrical Engineering; Ph.D., Ohio State University, 1963; appointed 1967.

**Gilman, Paul A.**

Thompson School Professor of Civil Technology; M.S., Pennsylvania State University, 1951; appointed 1945.

**Gilmore, Robert C.**

Associate Professor of History; Ph.D., Yale University, 1954; appointed 1952.

**Glanz, Filson H.**

Associate Professor of Electrical Engineering; Ph.D., Stanford University, 1965; appointed 1965.

**Goffe, Lewis C.**

Associate Professor of English; Ph.D., Boston University, 1961; appointed 1946.

**Gordon, Bernard K.**

Professor of Political Science; Ph.D., University of Chicago, 1959; appointed 1971.

**Grant, Clarence L.**

Professor of Chemistry; Ph.D., Rutgers University, 1960; appointed 1952-58, 1961.

**Graves, Donald H.**

Assistant Professor of Education; Ph.D., State University of Buffalo, 1973; appointed 1973.

**Green, D. MacDonald**

Professor of Biochemistry and Genetics; Ph.D., University of Rochester, 1958; appointed 1967.

**Grishman, Alan**

Associate Professor of Music; M.A., New York University, 1967; appointed 1967.

**Grossman, Lois S.**

Assistant Professor of Spanish; Ph.D., Rutgers University, 1972; appointed 1972.

**Haendler, Helmut M.**

Professor of Chemistry; Ph.D., University of Washington, 1940; appointed 1945.

**Hageman, Elizabeth H.**

Assistant Professor of English; Ph.D., University of North Carolina, 1971; appointed 1971.

**Hagstrom, Earl C.**

Associate Professor of Psychology; Ph.D., Brown University, 1957; appointed 1965.

**Haley, Russell**

Associate Professor of Administration; Ph.D., Union College, 1974; appointed 1975.

**Hall, Francis R.**

Professor of Hydrology; Ph.D., Stanford University, 1961; appointed 1964.

**Haney, James F.**

Assistant Professor of Zoology; Ph.D., University of Toronto, 1970; appointed 1972.

**Hansen, Larry J.**

Assistant Professor of Home Economics; Ph.D., Florida State University, 1973; appointed 1973.

**Hapgood, Robert**

Professor of English; Ph.D., University of California, 1955; appointed 1965.

**Harrington, Barry J.**

Assistant Professor of Physics; Ph.D., Harvard University, 1973; appointed 1975.

**Harris, Larry G.**

Associate Professor of Zoology; Ph.D., University of California, 1970; appointed 1969.

**Harter, Robert D.**

Associate Professor of Soil Chemistry; Ph.D., Purdue University, 1966; appointed 1969.

**Haugstad, May Biggs**

Assistant Professor of Botany; Ph.D., The Catholic University of America, 1971; appointed 1969.

**Hebert, David J.**

Associate Professor of Education; Ph.D., Kent State University, 1967; appointed 1967.

**Heckel, Maynard C.**

Dean of the School of Continuing Studies and Professor of Adult Education; Ed.D., Cornell University, 1961; appointed 1971.

**Heilbronner, Hans**

Professor of History; Ph.D., University of Michigan, 1954; appointed 1954.

**Henry, William F.**

Professor of Resource Economics; M.S., University of Connecticut, 1942; appointed 1952.

**Herbst, Edward J.**

Professor of Biochemistry; Ph.D., University of Wisconsin, 1949; appointed 1962.

**Hettinger, Stanley D.**

Assistant Professor of Music; M.M.E., VanderCook College, 1966; appointed 1965.

**Hill, John L.**

Professor of Wood Science and Technology; D.F., Yale University, 1954; appointed 1964.

**Hochgraf, Frederick G.**

Associate Professor of Materials Science; M.S., Cornell University, 1958; appointed 1958.

**Hocker, Harold W., Jr.**

Professor of Forest Resources and Genetics; D.F., Duke University, 1955; appointed 1955.

**Hoff, Phyllis**

Associate Professor of Physical Education; Ph.D., University of Southern California, 1967; appointed 1970.

**Holder, Mary E.**

Associate Professor of Home Economics; M.S., Michigan State University, 1949; appointed 1967.

**Holter, James B.**

Associate Professor of Animal Science; Ph.D., Pennsylvania State University, 1962; appointed 1963.

**Hoornebeck, Frank K.**

Associate Professor of Zoology and Genetics; Ph.D., Oregon State University, 1964; appointed 1964.

**Horrigan, James O.**

Professor of Business Administration; Ph.D., University of Chicago, 1967; appointed 1966.

**Hosek, William R.**

Associate Professor of Economics; Ph.D., University of California at Santa Barbara, 1967; appointed 1967.

**Houston, Robert E., Jr.**

Professor of Physics; Ph.D., Pennsylvania State University, 1957; appointed 1957.

**Howard, Cleveland L.**

Associate Professor of Music; D.M.A., Boston University, 1969; appointed 1969.

**Hoyle, Merrill C.**

Adjunct Assistant Professor of Plant Science; Ph.D., University of New Hampshire, 1971; appointed 1972.

**Hubbard, Colin D.**

Associate Professor of Chemistry; Ph.D., University of Sheffield, 1964; appointed 1967.

**Hudon, Louis J.**

Professor of French; Ph.D., Yale University, 1943; appointed 1961.

**Hurd, Richard W.**

Assistant Professor of Economics; Ph.D., Vanderbilt University, 1972; appointed 1973.

**Ikawa, Miyoshi**

Professor of Biochemistry; Ph.D., University of Wisconsin, 1948; appointed 1963.

**Irwin, Manley R.**

Professor of Economics; Ph.D., Michigan State University, 1963; appointed 1963.

**Jacoby, Robb**

Professor of Mathematics; Ph.D., University of Chicago, 1946; appointed 1961.

**James, Marion E.**

Associate Professor of History; Ph.D., Harvard University, 1955; appointed 1955.

**Jansen, Edmund F., Jr.**

Associate Professor of Resource Economics; Ph.D., North Carolina State University, 1966; appointed 1969.

**Jellison, Charles A., Jr.**

Professor of History; Ph.D., University of Virginia, 1956; appointed 1956.

**Jenks, R. Stephen**

Associate Professor of Organizational Behavior; Ph.D., Case Institute, 1966; appointed 1967.

**Johnson, Richard E.**

Professor of Mathematics; Ph.D., University of Wisconsin, 1941; appointed 1966.

**Jones, Galen E.**

Professor of Microbiology; Ph.D., Rutgers University, 1956; appointed 1966.

**Jones, Paul R.**

Professor of Chemistry; Ph.D., University of Illinois, 1956; appointed 1956.

**Jones, William R.**

Professor of History; Ph.D., Harvard University, 1958; appointed 1962.

**Kaen, Fred R.**

Assistant Professor of Finance; Ph.D., University of Michigan, 1968; appointed 1973.

**Kaufmann, Richard L.**

Professor of Physics; Ph.D., Yale University, 1960; appointed 1963.

**Kayser, John R.**

Associate Professor of Political Science; Ph.D., Claremont Graduate School and University Center, 1969; appointed 1969.

**Keener, Harry A.**

Dean of the College of Life Science and Agriculture, Director of the Agricultural Experiment Station, and Professor of Animal Science; Ph.D., Pennsylvania State College, 1941; appointed 1941.

**Kertzner, Robert**

Associate Professor of Physical Education; Ph.D., Michigan State University, 1965; appointed 1965.

**Khleif, Bud B.**

Associate Professor of Sociology and Education; Ph.D., Johns Hopkins University, 1957; appointed 1967.

**Kiang, Yun Tzu**

Associate Professor of Plant Sciences and Genetics; Ph.D., University of California, 1970; appointed 1970.

**Kimball, Roland B.**

Professor of Education; Ed.D., Harvard University, 1958; appointed 1963.

**Kinerson, Russell S., Jr.**

Assistant Professor of Botany; Ph.D., University of Washington, 1971; appointed 1973.

**Klippenstein, Gerald L.**

Associate Professor of Biochemistry; Ph.D., Northwestern University, 1967; appointed 1967.

**Klotz, Louis H.**

Associate Professor of Civil Engineering; Ph.D., Rutgers University, 1967; appointed 1965.

**Koch, David W.**

Assistant Professor of Plant Science; Ph.D., Colorado State University, 1971; appointed 1971.

**Kolodny, Annette**

Assistant Professor of English; Ph.D., University of California at Berkeley, 1969; appointed 1974.

**Korbel, John**

Professor of Economics and Business Administration; Ph.D., Harvard University, 1959; appointed 1966.

**Kuo, Shan S.**

Professor of Applied Mathematics; D. Eng., Yale University, 1958; appointed 1964.

**Ladd, Dwight R.**

Professor of Business Administration; D.B.A., Harvard University, 1956; appointed 1964.

**Lambert, Robert H.**

Professor of Physics; Ph.D., Harvard University, 1963; appointed 1955.

**Langley, Harold E., Jr.**

Associate Professor of Civil Engineering; Sc.D., Massachusetts Institute of Technology, 1957; appointed 1961.

**Larson, David L.**

Associate Professor of Political Science; Ph.D., Fletcher School, Tufts University, 1963; appointed 1965.

**Lavoie, Marcel E.**

Associate Professor of Zoology; Ph.D., Syracuse University, 1956; appointed 1950-52, 1955.

**Lawton, Edward J.**

Assistant Professor of Education; Ed.D., University of Virginia, 1970; appointed 1970.

**Leighton, Charles H.**

Professor of Spanish; Ph.D., Harvard University, 1961; appointed 1956.

**Limber, John E.**

Assistant Professor of Psychology; Ph.D., University of Illinois, 1969; appointed 1971.

**Limbirt, David E.**

Associate Professor of Mechanical Engineering; Ph.D., Case Western Reserve University, 1969; appointed 1969.

**Lind, E. Allan**

Assistant Professor of Psychology; Ph.D., University of North Carolina, 1973; appointed 1975.

**Lindberg, Gary H.**

Associate Professor of History; Ph.D., Stanford University, 1967; appointed 1974.

**Linden, Allen B.**

Associate Professor of History; Ph.D., Columbia University, 1969; appointed 1963.

**Linsky, Arnold S.**

Associate Professor of Sociology; Ph.D., University of Washington, 1966; appointed 1966.

**Lockwood, John A.**

Associate Director of Research and Professor of Physics; Ph.D., Yale University, 1948; appointed 1968.

**Loder, Theodore C., III**

Assistant Professor of Earth Sciences; Ph.D., University of Alaska, 1971; appointed 1972.

**Logan, Terence P.**

Associate Professor of English; Ph.D., Harvard University, 1966; appointed 1968.

**Long, David F.**

Professor of History; Ph.D., Columbia University, 1950; appointed 1948.

**Loy, James B.**

Associate Professor of Plant Sciences and Genetics; Ph.D., Colorado State University, 1967; appointed 1967.

**Lyle, Gloria G.**

Associate Professor of Chemistry; Ph.D., University of New Hampshire, 1958; appointed 1951.

**Lyle, Robert E., Jr.**

Professor of Chemistry; Ph.D., University of Wisconsin, 1949; appointed 1951.

**MacHardy, William E.**

Assistant Professor of Plant Pathology; Ph.D., University of Rhode Island, 1970; appointed 1972.

**Marshall, Grover E.**

Assistant Professor of French and Italian; Ph.D., Princeton University, 1971; appointed 1965.

**Mathieson, Arthur C.**

Professor of Botany; Ph.D., University of British Columbia, 1965; appointed 1965.

**Mathur, Virendra K.**

Assistant Professor; Ph.D., University of Missouri at Rolla, 1970; appointed 1974.

**Mautz, William W.**

Associate Professor of Wildlife Ecology; Ph.D., Michigan State University, 1969; appointed 1969.

**Mayewski, Paul A.**

Assistant Professor of Earth Sciences; Ph.D., Ohio State University, 1973; appointed 1974.

**McCann, Francis D., Jr.**

Associate Professor of History; Ph.D., Indiana University, 1967; appointed 1971.

**Meeker, Loren David**

Associate Professor of Mathematics; Ph.D., Stanford University, 1965; appointed 1970.

**Melvin, Donald W.**

Associate Professor of Electrical Engineering; Ph.D., Syracuse University, 1970; appointed 1957.

**Menge, Carleton P.**

Professor of Education; Ph.D., University of Chicago, 1948; appointed 1948.

**Mennel, Robert M.**

Associate Professor of History; Ph.D., Ohio State University, 1969; appointed 1969.

**Merton, Andrew H.**

Assistant Professor of English; B.A., University of New Hampshire, 1967; appointed 1972.

**Messier, Victor**

Assistant Professor of Home Economics; Ph.D., Pennsylvania State University, 1973; appointed 1970.

**Metcalf, Theodore G.**

Professor of Microbiology; Ph.D., University of Kansas, 1950; appointed 1956.

**Miaoulis, George**

Assistant Professor of Business Administration; Ph.D., New York University, 1973; appointed 1973.

**Miccinati, Jeannette**

Assistant Professor of Education; Ph.D., Cornell University, 1975; appointed 1975.

**Miller, Edmund G.**

Professor of English; Ph.D., Columbia University, 1955; appointed 1951.

**Mills, Eugene S.**

President and Professor of Psychology; Ph.D., Claremont Graduate School, 1952; appointed 1962.

**Mills, Richard L.**

Associate Professor of Economics and Business Administration; Ph.D., Indiana University, 1967; appointed 1967.

**Milne, Lorus J.**

Professor of Zoology; Ph.D., Harvard University, 1936; appointed 1948.

**Minocha, Subhash**

Assistant Professor of Botany; Ph.D., University of Washington, 1974; appointed 1974.

**Moore, Berrien, III**

Associate Professor of Mathematics; Ph.D., University of Virginia, 1969; appointed 1969.

**Moore, David W.**

Assistant Professor of Political Science; Ph.D., Ohio State University, 1970; appointed 1972.

**Morris, Douglas E.**

Adjunct Assistant Professor of Resource Economics; Ph.D., Oklahoma State University, 1972; appointed 1972.

**Morrison, James D.**

Professor of Chemistry; Ph.D., Northwestern University, 1962; appointed 1965.

**Mosberg, William**

Associate Professor of Mechanical Engineering; M.Eng., Yale University, 1960; appointed 1958.

**Mott, Basil J.F.**

Dean of School of Health Studies and Professor of Health Services Administration and Planning; Ph.D., Harvard University, 1967; appointed 1973.

**Mower, Lyman**

Professor of Physics; Ph.D., Massachusetts Institute of Technology, 1953; appointed 1957.

**Mulhern, John E., Jr.**

Professor of Physics; Ph.D., Boston University, 1954; appointed 1954.

**Munroe, M. Evans**

Professor of Mathematics; Ph.D., Brown University, 1945; appointed 1959.

**Murdoch, Joseph B.**

Professor of Electrical Engineering; Ph.D., Case Institute of Technology, 1962; appointed 1952.

**Murphy, Stephen T.**

Assistant Professor of Education; Ph.D., State University of New York at Buffalo, 1973; appointed 1974.

**Murray, Donald M.**

Professor of English; B.A., University of New Hampshire, 1948; appointed 1963.

**Nahin, Paul J.**

Assistant Professor of Electrical Engineering; Ph.D., University of California, 1972; appointed 1975.

**Nevin, John A.**

Professor of Psychology; Ph.D., Columbia University, 1963; appointed 1972.

**Nicoloff, Philip L.**

Professor of English; Ph.D., Columbia University, 1959; appointed 1954.

**Nielson, Melville**

Associate Dean of the College of Liberal Arts and Associate Professor of Sociology; Ph.D., Ohio State University, 1955; appointed 1950.

**Nordgren, Eric A.**

Professor of Mathematics; Ph.D., University of Michigan, 1964; appointed 1964.

**O'Brien, Dennis J.**

Assistant Professor of Civil Engineering; Ph.D., University of Maryland, 1974; appointed 1974.

**O'Connell, Lawrence W.**

Associate Professor of Political Science; Ph.D., Syracuse University, 1968; appointed 1966.

**O'Connor, James T., Jr.**

Associate Professor of Animal Science and Extension Animal Scientist; D.V.M., University of Pennsylvania, 1941; appointed 1969.

**Olson, David P.**

Associate Professor of Wildlife Ecology; Ph.D., University of Minnesota, 1964; appointed 1968.

**Ossenbruggen, Paul J.**

Associate Professor of Civil Engineering; Ph.D., Carnegie-Mellon University, 1970; appointed 1975.

**Owens, Charles W.**

Associate Professor of Chemistry; Ph.D., University of Kansas, 1963; appointed 1963.

**Palmer, Stuart H.**

Professor of Sociology; Ph.D., Yale University, 1955; appointed 1955.

**Paul, Nicholas L.**

Assistant Professor of Occupational Education; Ed.D., North Carolina State University, 1973; appointed 1973.

**Peirce, Lincoln C.**

Professor of Plant Science and Genetics; Ph.D., University of Minnesota, 1958; appointed 1964.

**Peterson, Nobel K.**

Associate Professor of Soil and Water Science; Ph.D., Rutgers University, 1957; appointed 1957.

**Petroski, Joseph J.**

Associate Professor of Education; Ed.D., Harvard University, 1960; appointed 1966.

**Pfanner, Helmut F.**

Associate Professor of German; Ph.D., Stanford University, 1965; appointed 1969.

**Pierce, Edward R.**

Associate Dean, College of Health Studies and Associate Professor of Health Studies; Ph.D., University of Louisville, 1962; appointed 1974.

**Pilar, Frank L.**

Professor of Chemistry; Ph.D., University of Cincinnati, 1957; appointed 1957.

**Pine, Gerald J.**

Professor of Education; Ed.D., Boston University, 1963; appointed 1966.

**Pistole, Thomas G.**

Assistant Professor of Microbiology; Ph.D., University of Utah, 1969; appointed 1971.

**Plager, Dean**

Instructor of Administration; M.B.A., University of Denver, 1970; appointed 1975.

**Pokoski, John L.**

Associate Professor of Electrical Engineering; Ph.D., Montana State University, 1967; appointed 1967.

**Polk, Keith**

Associate Professor of Music; Ph.D., University of California at Berkeley, 1968; appointed 1964.

**Poll, Solomon**

Professor of Sociology; Ph.D., University of Pennsylvania, 1960; appointed 1964.

**Pollard, James E.**

Assistant Professor of Plant Science; Ph.D., University of Florida, 1969; appointed 1970.

**Porter, Clarence A.**

Assistant Vice Provost for Academic Affairs and Adjunct Associate Professor of Zoology; Ph.D., Oregon State University, 1966; appointed 1972.

**Potter, Hugh M., III**

Assistant Professor of English; Ph.D., University of Minnesota, 1965; appointed 1962.

**Prince, Allan B.**

Vice Provost for Budget and Administration and Professor of Soil and Water Science; Ph.D., Rutgers University, 1950; appointed 1954.

**Puth, Robert C.**

Associate Professor of Economics; Ph.D., Northwestern University, 1967; appointed 1967.

**Radlow, James**

Professor of Applied Mathematics; Ph.D., New York University, 1957; appointed 1965.

**Rasmussen, Mary H.**

Associate Professor of Music; M.M., University of Illinois, 1952; M.L.S., University of Illinois, 1956; appointed 1968.

**Reeves, Roger Marcel**

Associate Professor of Entomology and Forest Resources; Ph.D., S.U.N.Y. College of Forestry, Syracuse University, 1964; appointed 1964.

**Repka, Frank J.**

Assistant Professor of Animal Science; Ph.D., Cornell University, 1972; appointed 1972.

**Reyna, Stephen P.**

Assistant Professor of Anthropology; Ph.D., Columbia University, 1972; appointed 1973.

**Rich, Avery E.**

Associate Dean of College of Life Sciences and Agriculture and Professor of Plant Pathology; Ph.D., State College of Washington, 1950; appointed 1941-43, 1951.

**Richardson, John C.**

Professor of English; Ph.D., Boston University, 1959; appointed 1946.

**Rogers, John E.**

Associate Professor of Music; M.F.A., Princeton University, 1966; appointed 1967.

**Rogers, Owen M.**

Professor of Plant Science and Genetics; Ph.D., Pennsylvania State University, 1959; appointed 1959.

**Romoser, George K.**

Professor of Political Science; Ph.D., University of Chicago, 1958; appointed 1961-62, 1967.

**Rose, Alan H.**

Assistant Professor of English; Ph.D., Indiana University, 1970; appointed 1969.

**Rosen, Sam**

Professor of Economics; Ph.D., Harvard University, 1952; appointed 1957.

**Rosenbush, Michael J.**

Associate Professor of Russian; Ph.D., University de Montreal, 1970; appointed 1972.

**Ross, Shepley L.**

Professor of Mathematics; Ph.D., Boston University, 1953; appointed 1955.

**Rothwell, Kenneth J.**

Professor of Economics; Ph.D., Harvard University, 1960; appointed 1963.

**Rouman, John C.**

Associate Professor of Classics; Ph.D., University of Wisconsin, 1965; appointed 1965.

**Routley, Douglas G.**

Professor of Plant Science; Ph.D., Pennsylvania State University, 1957; appointed 1957.

**Russell, Robert D.**

Assistant Professor of Mathematics; Ph.D., Stanford University, 1967; appointed 1975.

**Rutman, Darrett B.**

Professor of History; Ph.D., University of Virginia, 1959; appointed 1968.

**Samuels, Fred**

Associate Professor of Sociology; Ph.D., University of Massachusetts, 1966; appointed 1966.

**Sasner, John J., Jr.**

Associate Professor of Zoology; Ph.D., University of California, 1965; appointed 1965.

**Savage, Godfrey H.**

Professor of Mechanical Engineering; Ph.D., Stanford University, 1970; appointed 1965.

**Sawyer, Albert K.**

Professor of Chemistry; M.S., University of Maine, 1947; appointed 1949.

**Sawyer, Philip J.**

Professor of Zoology; Ph.D., University of Michigan, 1956; appointed 1952.

**Schibanoff, Susan**

Assistant Professor of English; Ph.D., University of California at Los Angeles, 1971; appointed 1971.

**Schickedanz, David I.**

Assistant Professor of Psychology; Ph.D., University of Illinois, 1973; appointed 1973.

**Schmidt, Marty J.**

Assistant Professor of Psychology; Ph.D., Purdue University, 1972; appointed 1972.

**Schneer, Cecil J.**

Professor of Geology; Ph.D., Cornell University, 1954; appointed 1950, 1954.

**Schreiber, Richard W.**

Professor of Botany; Ph.D., University of Wisconsin, 1955; appointed 1957.

**Schwab, Charles**

Assistant Professor of Animal Sciences; Ph.D., University of Wisconsin, 1974; appointed 1975.

**Schwarz, Marc L.**

Associate Professor of History; Ph.D., University of California at Los Angeles, 1965; appointed 1967.

**Shapiro, Howard M.**

Associate Professor of Sociology; Ph.D., University of Minnesota, 1969; appointed 1969.



**Shar, Albert O.**

Assistant Professor of Mathematics; Ph.D., University of Pennsylvania, 1970; appointed 1971.

**Shepard, Harvey K.**

Associate Professor of Physics; Ph.D., California Institute of Technology, 1966; appointed 1969.

**Sherman, Heidemarie C.**

Assistant Professor of Economics; Ph.D., Wayne State University, 1971; appointed 1967.

**Sherman, James L.**

Assistant Professor of German; Ph.D., University of Michigan, 1969; appointed 1967.

**Shor, Ronald E.**

Professor of Psychology; Ph.D., Brandeis University, 1960; appointed 1967.

**Shore, Barry**

Associate Professor of Administration; Ph.D., University of Wisconsin, 1968; appointed 1974.

**Shore, Samuel D.**

Associate Professor of Mathematics; Ph.D., Pennsylvania State University, 1964; appointed 1965.

**Siddall, David V.**

Assistant Professor of English; Ph.D., Indiana University, 1970; appointed 1965.

**Silver, Judith A.**

Assistant Professor of History; Ph.D., University of Michigan, 1973; appointed 1973.

**Silverman, Robert J.**

Professor of Mathematics; Ph.D., University of Illinois, 1952; appointed 1962.

**Simic, Charles D.**

Associate Professor of English; B.A., New York University, 1967; appointed 1973.

**Simpson, Robert E.**

Associate Professor of Physics; Ph.D., Harvard University, 1960; appointed 1963.

**Sir, W. Niel**

Assistant Professor of Music; M.A., University of California, 1962; appointed 1970.

**Sivaprasad, Kondagunta**

Associate Professor of Electrical Engineering; Ph.D., Harvard University, 1963; appointed 1969.

**Skoglund, Winthrop C.**

Professor of Animal Science; Ph.D., Pennsylvania State University, 1958; appointed 1950.

**Slanetz, Lawrence W.**

Professor of Microbiology; Ph.D., Yale University, 1932; appointed 1932.

**Smith, Gerald L.**

Associate Professor of Animal Science; M.S., Pennsylvania State College, 1951; appointed 1948.

**Smith, M. Daniel**

Associate Professor of Education; Ed.D., Harvard University, 1961; appointed 1967.

**Smith, Elizabeth C.**

Lecturer in Animal Science; Ph.D., Pennsylvania State University, 1958; appointed 1968.

**Smith, James A.**

Associate Dean of the College of Liberal Arts and Adjunct Associate Professor of Economics; Ph.D., Washington State University, 1967; appointed 1972.

**Smith, Mark R.**

Associate Professor of English; B.A., Northwestern University, 1960; appointed 1966.

**Smith, Roderick M.**

Assistant Professor of Zoology; Ph.D., University of Massachusetts, 1969; appointed 1974.

**Smith Samuel C.**

Professor of Animal Science and Biochemistry; Ph.D., Pennsylvania State University, 1962; appointed 1961.

**Snell, Elizabeth A.**

Associate Professor of Home Economics; Ph.D., Cornell University, 1971; appointed 1971.

**Spitz, Allan A.**

Dean of the College of Liberal Arts and Professor of Political Science; Ph.D., Michigan State University, 1964; appointed 1971.

**Sprague, Linda G.**

Associate Professor of Business Administration; M.B.A., Boston University; 1967; appointed 1969.

**Squires, Edward L.**

Assistant Professor of Animal Science; M.S., West Virginia University, 1973; appointed 1973.

**Stackhouse, Larry L.**

Associate Professor of Animal Science; Ph.D., Colorado State University, 1970; appointed 1970.

**Steele, Donald E.**

Professor of Music; M.A., Colorado College, 1952; appointed 1946.

**Stewart, Glenn W.**

Associate Professor of Geology and State Geologist; M. A., Harvard University, 1950; appointed 1938-39, 1941.

**Stewart, James A.**

Associate Professor of Biochemistry; Ph.D., University of Connecticut, 1967; appointed 1968.

**Stone, Deborah E.**

Associate Professor of Education; Ed.D., Boston University, 1971; appointed 1962.

**Stotz, Kerwin C.**

Associate Professor of Electrical Engineering; Ph.D., Rensselaer Polytechnic Institute, 1963; appointed 1964.

**Straus, Murray A.**

Professor of Sociology; Ph.D., University of Wisconsin, 1956; appointed 1968.

**Strout, Richard G.**

Professor of Animal Science; Ph.D., University of New Hampshire, 1961; appointed 1954.

**Swan, Emery F.**

Professor of Zoology; Ph.D., University of California, 1942; appointed 1952.

**Taft, Charles K.**

Professor of Mechanical Engineering; Ph.D., Case Institute of Technology, 1960; appointed 1967.

**Teeri, Arthur E.**

Professor of Biochemistry; Ph.D. Rutgers University, 1943; appointed 1938-40, 1943.

**Thompson, Alan R.**

Assistant Professor of Economics; Ph.D., University of Texas at Austin, 1973; appointed 1974.

**Tillinghast, Edward K.**

Associate Professor of Zoology; Ph.D., Duke University, 1966; appointed 1967.

**Tischler, Herbert**

Professor of Geology; Ph.D., University of Michigan, 1961; appointed 1965.

**Trout, Ben T.**

Assistant Professor of Political Science; Ph.D., Indiana University, 1972; appointed 1969.

**Uebel, J. John**

Associate Professor of Chemistry; Ph.D., University of Illinois, 1964; appointed 1964.

**Ulrich, Gail D.**

Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1964; appointed 1970.

**Urban, Willard E., Jr.**

Associate Professor of Biometrics and Genetics; Ph.D., Iowa State University, 1963; appointed 1963.

**Valentine, Russell L.**

Associate Professor of Mechanical Engineering; M.S.M.E., Purdue University, 1953; appointed 1953.

**Van Osdol, Donovan Harold**

Associate Professor of Mathematics; Ph.D., University of Illinois, 1969; appointed 1970.

**Verrette, Paul F.**

Assistant Professor of Music; M.A., Boston University, 1971; appointed 1962.

**Vincent, Donald E.**

Professor, Librarian; Ph.D., University of Michigan, 1974; appointed 1962.

**Voll, John O.**

Associate Professor of History; Ph.D., Harvard University, 1969; appointed 1965.

**Vreeland, Robert P.**

Associate Professor of Civil Engineering; M.E., Yale University, 1941; appointed 1966.

**Vrooman, Jack R.**

Associate Professor of French; Ph.D., Princeton University, 1965; appointed 1971.

**Wallace, Oliver P., Sr.**

Associate Professor of Forest Resources; Ph.D., University of Michigan, 1954; appointed 1958.

**Wang, Tung-Ming**

Associate Professor of Civil Engineering; Ph.D., Northwestern University, 1960; appointed 1961.

**Warren, Jerry A.**

Director of Academic Computer Activities, Associate Professor of Plant Science; Ph.D., Cornell University, 1960; appointed 1971.

**Wear, Robert E.**

Associate Professor of Physical Education; Ph.D., University of Michigan, 1955; appointed 1964.

**Webb, Dwight**

Associate Professor of Education; Ph.D., Stanford University, 1967; appointed 1967.

**Webber, William R.**

Professor of Physics; Ph.D., University of Iowa, 1957; appointed 1969.

**Weber, James H.**

Associate Professor of Chemistry; Ph.D., Ohio State University, 1963; appointed 1963.

**Weber, Stephen J.**

Assistant Professor of Psychology; Ph.D., Northwestern University, 1971; appointed 1971.

**Weesner, Theodore W.**

Associate Professor of English; M.F.A., University of Iowa, 1965; appointed 1966.

**Weiland, Walter E.**

Associate Professor of Physical Education; Ph.D., Pennsylvania State University, 1964; appointed 1964.

**Wells, Donald D.**

Instructor in Business Administration; M.B.A., University of Connecticut, 1968; appointed 1971.

**Wells, Otho S.**

Associate Professor of Plant Science; Ph.D., Rutgers University, 1966; appointed 1966.

**Wetzel, William E.**

Associate Professor of Business Administration; M.B.A., Temple University, 1965; appointed 1967.

**Weyrick, Richard R.**

Associate Professor of Forest Resources; Ph.D., University of Minnesota, 1968; appointed 1970.

**Wheeler, Charles M., Jr.**

Professor of Chemistry; Ph.D., West Virginia University, 1951; appointed 1950.

**Wheeler, Douglas L.**

Professor of History; Ph.D., Boston University, 1963; appointed 1965.

**Wheeler, Ellsworth H., Jr.**

Assistant Professor of Zoology; Ph.D., University of Rhode Island, 1968; appointed 1970.

**White, Susan O.**

Assistant Professor of Political Science; Ph.D., University of Minnesota, 1970; appointed 1969.

**Whitlock, John B.**

Associate Professor of Music; Ph.D., State University of Iowa, 1958; appointed 1958.

**Wicks, John D.**

Professor of Music; Ph.D., Harvard University, 1959; appointed 1956.

**Wight, Thomas**

Assistant Professor of Animal Science; Ph.D., University of New Hampshire, 1972; appointed 1973.

**Wilcox, Donald J.**

Professor of History; Ph.D., Harvard University, 1967; appointed 1970.

**Williams, Daniel C.**

Associate Professor of Psychology; Ph.D., University of California at Santa Barbara, 1970; appointed 1970.

**Williams, Thomas A., Jr.**

Professor of English; M.A., University of New Hampshire, 1958; appointed 1958.

**Willits, Robin D.**

Professor of Business Administration; Ph.D., Massachusetts Institute of Technology, 1965; appointed 1965.

**Wilson, John A.**

Associate Professor of Mechanical Engineering; Ph.D., Northeastern University, 1970; appointed 1960.

**Wing, Henry J., Jr.**

Assistant Professor of Music; Ph.D., Boston University, 1966; appointed 1970.

**Winn, Alden L.**

Professor of Electrical Engineering; S.M., Massachusetts Institute of Technology, 1948; appointed 1948.

**Woodward, William R.**

Instructor of Psychology; Ph.D., Yale University, 1975; appointed 1975.

**Wright, John J.**

Assistant Professor of Physics; Ph.D., University of New Hampshire, 1969; appointed 1970.

**Wright, Paul A.**

Professor of Zoology; Ph.D., Harvard University, 1944; appointed 1958.

**Wrightsmann, Dwayne E.**

Professor of Finance; Ph.D., Michigan State University, 1964; appointed 1964.

**Wurzberg, Frederic W.**

Associate Professor of Political Science; Ph.D., Columbia University, 1961; appointed 1963.

**Wyman, Charles E.**

Assistant Professor of Chemical Engineering; Ph.D., Princeton University, 1971; appointed 1974.

**Yildiz, Asim**

Professor of Mechanics; D.Eng., Yale University, 1959; appointed 1967.

**Yount, John A.**

Professor of English; M.F.A., State University of Iowa, 1962; appointed 1962-64, 1965.

**Zoller, J. Harold**

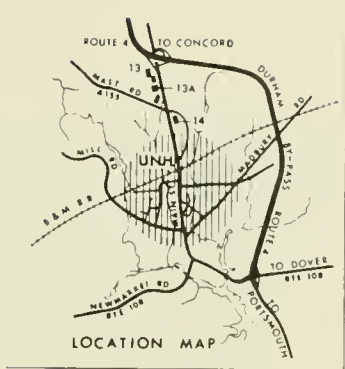
Professor of Civil Engineering; Ph.D., University of Wisconsin, 1953; appointed 1958.

**Zsigray, Robert M.**

Assistant Professor of Microbiology and Genetics; Ph.D., Georgetown University, 1969; appointed 1970.

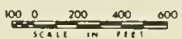
# Campus Map and Key

Adams Residential Tower (N.E. Center)	70a	Gibbs Hall	50	O'Connell House	84
Admissions Office	35	Graduate School	41	Ombudsman	43
Agricultural Experiment Station	22	Greenhouses	8	Palmer House	78a
Agronomy Field Station	11	Hamilton Smith Hall	43	Parsons Hall	31
Alexander Hall	55	Health Studies, School of	27	Paul Creative Arts Center	32
Alumni House	74	Hennessy Theater	32	Pettee Hall	21
Analytical Services Laboratory	23	Hersey House	75b	Philbrook Dining Hall	36
Babcock House	39	Hetzel Hall	56	Poultry Plant	3
Barton Hall	9a	Hewitt Hall	27	President's Office	35
Batcheller House	78	Hitchcock Hall	44	Public Administration Service	41
Bookstore	27a	Hood House Infirmary	42	Putnam Hall	9
Brackett Field	4	Horse Barn	10	Randall Hall	45
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Center for Industrial and Institutional Development	40	International House	80	Richards House	77
Christensen Hall	37	International Students' Adviser	53	Ritzman Nutrition Laboratory	2
College Woods	1	James Hall	29	Safety Services	19
Computation Center	24	Janetos House	83	Sawyer Hall	71
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UNIVERSITY OF NEW HAMPSHIRE  
 DURHAM NEW HAMPSHIRE

CAMPUS MAP





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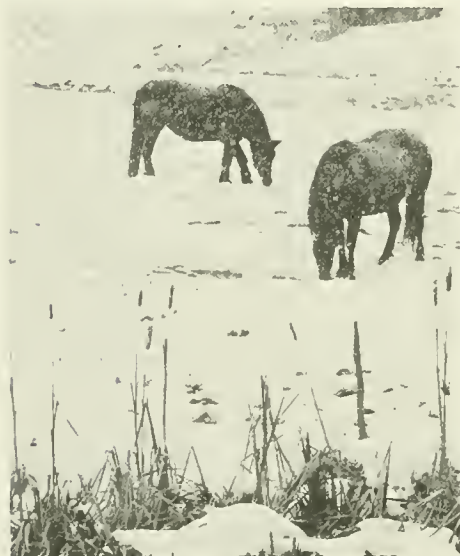
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# Graduate School Calendar 1976-77

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## Semester I



September 5, Sunday  
September 7, Tuesday  
September 8, Wednesday  
September 11, Saturday  
September 24, Friday  
October 1, Friday  
October 7, Thursday  
November 3, Wednesday

November 11, Thursday  
November 22, Monday  
November 24, Wednesday

November 29, Monday  
December 3, Friday  
December 10, Friday

December 17, Friday  
December 19, Sunday  
December 20, Monday  
December 23, Thursday

8 a.m. Residence Halls open  
Registration  
8 a.m. Classes begin  
Classes hold Friday schedule  
Last day to drop courses without \$10 late drop fee  
Last day to add courses without \$10 late add fee  
Last day for partial tuition refund on withdrawal  
Mid-semester, last day to drop courses or withdraw without academic liability  
No classes—University holiday—Veterans Day  
Pre-registration Semester II begins  
Classes hold Thursday schedule; 7 p.m. Thanksgiving recess begins  
8 a.m. Classes resume  
Last day for final Ph.D. oral examination (December graduation)  
Last day for presenting final copies of dissertation or thesis to the Graduate School for binding (December graduation)  
Reading day  
Commencement  
8 a.m. Semester I final exams begin  
6 p.m. Final exams end

## Semester II



January 23, Sunday  
January 24, Monday  
February 4, Friday  
February 11, Friday  
February 22, Tuesday  
March 18, Friday

March 28, Monday  
April 11, Monday  
May 6, Friday  
May 13, Friday

May 16-17, Monday-Tuesday  
May 18, Wednesday  
May 24, Tuesday  
May 29, Sunday

Registration  
8 a.m. Classes begin  
Last day to drop courses without \$10 late drop fee  
Last day to add courses without \$10 late add fee  
Last day for partial tuition refund on withdrawal  
Mid-semester, last day to drop courses or withdraw without academic liability; 7 p.m. Spring recess begins  
8 a.m. Classes resume  
8 a.m. Pre-registration for Semester I, 1977-78 begins  
Last day for final Ph.D. oral examination (May graduation)  
Last day for presenting final copies of dissertation and thesis to the Graduate School for binding (May graduation)  
Reading days  
8 a.m. Semester II final exams begin  
Final exams end  
Commencement

The University reserves the right to modify the calendar subsequent to printing.



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Durham, New Hampshire 03824

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