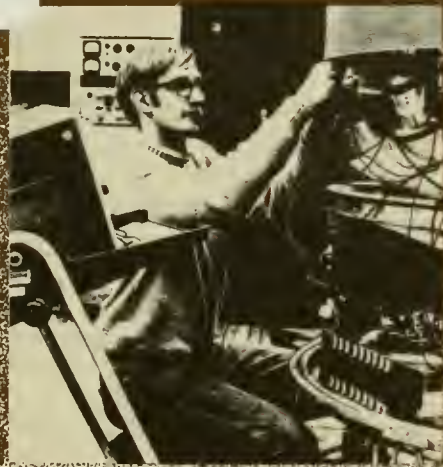
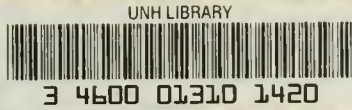


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# Journal of the University of New Hampshire



Graduate School Issue



# The Graduate School 1974-75

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University of New Hampshire

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**UNH System Components**



**Route Numbers**



# 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  
French  
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

## Master of Public Administration

Political Science

## Doctor of Philosophy

Biochemistry  
Botany  
Chemistry  
Economics  
Engineering  
English  
Genetics  
History  
Mathematics  
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 and 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 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. The Graduate School participates in the New England Regional Student Program. This program provides for New England residents to be charged in-state rates when 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). Additional information concerning this program may be obtained from the New England Board of Higher Education, 40 Grove Street, Wellesley, Massachusetts 02181.

## 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 Psy-





chology 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.

Student 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 banks of the largest estuary on the Atlantic Coast, the University has long had an interest in marine affairs including both engineering and biological aspects. Two interdisciplinary programs focus on this area.

1. An example of University interest in marine science is the recently constructed Jackson Estuarine Laboratory and the research vessel, R/V *Jere A. Chase*. A graduate student who wishes to emphasize marine science or oceanography in his graduate work may do so by selecting courses in the departments of Biochemistry, Botany, Earth Sciences, Microbiology, and Zoology. For further information, write to the Office of Marine Science and Technology, Kingsbury Hall.

2. The Engineering Design and Analysis Laboratory (EDAL) is an interdisciplinary faculty group mainly from the College of Technology, whose purpose is to involve both faculty and students in realistic and challenging ocean engineering projects. Students in master's programs in Chemical, Civil, Electrical, and Mechanical Engineering, or the Engineering Ph.D. program may elect an Ocean Engineering orientation. For information regarding EDAL activities, write to the Office of Marine Science and Technology.



# 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 contributes to graduate education directly by creating an opportunity for graduate students to learn research methods by participating with their instructors as part of research teams. The goal of research, of course, is to share the University's discoveries and applications with other scholars and the people of the state and region.

## 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**, the University's newest research facility, 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 tide-water area in the Great Bay estuarine complex covers more than 15,000 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 steaming distance 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 shop for maintenance of oceanographic gear; a small library-conference area; a research vessel, R/V *Jere A. Chase*; and a pier for docking research vessels.

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 a mass spectrometer, an optical rotatory dispersion spectrophotometer, a nuclear magnetic resonance spectrometer, a Van de Graaff generator, an amino acid analyzer, electron microscopes, a gas chromatograph, an electron spin resonance spectrometer, and the IBM 360/50 computer center. Students from all disciplines may make arrangements for their 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



The University Library houses 650,000 volumes, 5,000 periodicals, and substantial microform and audio-tape collections. Specialized subject collections are housed in four branches: Chemistry in Parsons Hall, Engineering and Mathematics in Kingsbury Hall, Biological Sciences in Kendall Hall, and Physics in DeMeritt Hall. Each branch is administered by a librarian with special skills in the appropriate subject area. 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 the staff includes a full-time documents librarian.

The Dimond Library serves the University and as the Durham Public Library; and a graduate student's spouse and children may use the facilities, including 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.

The library contains a study room which is open 24 hours a day, seven days a week, throughout the entire year.

# 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. The sex, race, religion, color, and national origin of applicants is not considered in the admissions process.

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.

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.

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## 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 confidential letters of recommendation from persons in a position to judge the applicant's preparation and fitness for graduate work, e.g., previous instructors or coworkers of the applicant. Letters must be forwarded directly by the referee to the Graduate School. Material from college placement offices which was not prepared within the last twelve months is not acceptable.
4. A \$10 application fee. This fee is nonrefundable.



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## **Applicants from Foreign Countries**

5. Any additional materials, such as scores achieved on the Graduate Record Examination or Aptitude Test for the Graduate Study of Business, which are required by the department or program to which the applicant is applying. Such scores must be forwarded directly from the testing agency.

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. This review normally is conducted by a departmental committee composed of graduate faculty members. The dean of the Graduate School carefully reviews the applicant's file and the department's recommendation. After making the final decision, the dean of 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 ATGSB. All of the material which is submitted as part of an application will receive careful consideration.

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.

## 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 any 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 must complete the special student registration form which is available during the registration period each semester. This form must be filed by all special students whether they register for day courses at the University, or courses offered by the Division of Continuing Education, at the Merrimack Valley Branch, or in the summer session. Special students are not required to file an application 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 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 such as: evidence of additional academic achievement, or more recent and significantly improved GRE or ATGSB 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.

**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

Graduate students pay course charges according to the number of credits and level of courses for which they enroll each semester. For 700- and 800-level course registrations this rate is \$42.00 per credit for residents of New Hampshire and \$95.00 per credit for non-residents of New Hampshire. Graduate students registering for courses at the 400, 500, and 600 levels pay course charges at the rate of \$30.00 per credit for residents of New Hampshire and \$60.00 per credit for non-residents of New Hampshire. A student's eligibility for New Hampshire residency will be determined on the basis of the information submitted as part of the application. (See page 150 for a complete statement of the University's regulations regarding eligibility for classification as a New Hampshire resident for tuition purposes.)

The above charges will apply to admitted graduate students enrolling for courses at the University at Durham during the academic year. 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.

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### Thesis and In Absentia Fees

**Master's Students:** Master's students registering for thesis credits (899) will pay by the credit until they have registered for the 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 theses 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) for a minimum of two semesters. The fee for this registration will be \$300.00 per semester or \$150.00 per summer session.

Doctoral candidates not working on the campus 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 \$12.50 per semester and a student-services fee of \$5 per semester must be paid by all admitted students.

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 during 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.

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

## Financial Aid

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### Assistantships and Fellowships

Approximately 300 graduate 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 be full-time students (i.e., registered for two or more full courses or equivalent thesis credits or doctoral research) during each semester in which they hold their appointments.



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 graduate assistants are \$2800 per academic year and may include a waiver of tuition and academic fees for the academic year and the following summer upon recommendation of the department chairman and appropriate dean.

**Project Assistants:** An assistant who assists faculty members in an external-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 resident rate.

Full-time summer employment may be available for project assistants or graduate assistants. Assistants employed during the summer are paid up to \$560 per month for a maximum of two months full-time employment. Students so employed are not normally permitted to register for courses in the summer session.

Inquiries regarding assistantships should be addressed to the chairman 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/non-resident 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 dean of the Graduate School.



## Federally Funded Traineeships and Fellowships



**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 \$2800 for the first academic year, \$3000 for the second academic year, and \$3200 for the third academic year. In addition the award provides \$750 support for each of two summers, waiver of tuition, and an annual allotment of \$500 each for up to two qualified dependents. 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 dean of the Graduate School.

**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.

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 \$3000 for 12 months of study plus tuition waiver.

Awards may be available for certain graduate programs in the departments of Education, English, and Sociology. Students should contact these departments directly concerning these awards.

Application for the following awards should be made to the offices noted:

**Public Health Service Traineeships and Fellowships:** Awards are made for study in health-related fields by the National Institutes of Health and other federal agencies. Applications should be made directly to Career Development Review Branch, Division of Research Grants, National Institutes of Health, Public Health Service, Bethesda, Maryland 20014.

**National Science Foundation Graduate Fellowships:** Awarded to master’s and doctoral students in the mathematical, physical, medical, biological, engineering, and social sciences, and in the history and philosophy of science. Applications should be made to the Fellowship Office, National Research Council, 2101 Constitution Avenue N.W., Washington, D.C. 20418.

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## Loan and Work-Study Programs

**National Defense Student Loans:** To be eligible for consideration, a student must: carry 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 carry at least one half the full-time academic load as defined by the University. 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 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. Eligibility is based upon financial need and is determined by the Financial Aid Office. Work during the academic year is usually on campus and may be up to 40 hours per week.

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

When a student is admitted to the Graduate School, he will be assigned an adviser whose academic interests parallel those of the graduate student. Students will plan their programs in consultation with their advisers.

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 his 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 dean of the Graduate School who 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.

---

## 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.)

Upon recommendation of the department, superior 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 before enrolling in the courses. (See admission requirements for UNH seniors.)

In some departments or programs it is possible for students to do a part of their work during the summer session or in the Division of Continuing Education. Students should consult the Summer Session or Division of Continuing Education Office in Huddleston Hall concerning the courses offered and course schedules. Students intending to graduate in September, 1974, must present dissertation or thesis to the Graduate School Office by August 16; the last day for final Ph.D. and master's examinations and completion of all degree requirements is August 23.

**Grades:** Graduate grades are A, B+, B. Any grade below the B level (C+, C, D+, D, F) will not count toward 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.

For complete and approved theses and dissertations, a grade of Credit (Cr) is given.

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 Science, Master of Occupational Education, Master of Business Administration, and Master of Public Administration, 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 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 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 dean of 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 dean of the Graduate School is, ex officio, a member of all examining committees.

**Master's Thesis:** A thesis may be required of candidates for the Master 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 chairman and approved by the dean of the Graduate School.



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## Requirements for Doctoral Degrees



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 not less than two weeks 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 these 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. Graduate 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 resident predoctoral students must register each semester until requirements for the degree have been completed. The minimum requirement for the doctorate is three years beyond the bachelor's degree. 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 chairman 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 concentration and appointed by the dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments. The dean of the Graduate School is an ex officio member of all doctoral committees.

The student may not be advanced to candidacy for the Ph.D. until 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. Following the examination and two weeks prior to Commencement, two copies of the approved dissertation, ready for binding, shall be turned in to the Graduate Office, together with a receipt for the binding fee from the University Bookstore.

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 chairman of the department or the chairman 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. All course registrations for day courses must be completed through 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 and are enrolled for a minimum of two full courses, or equivalent thesis credits, or doctoral research registration.

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 (75 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 (15 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 utilized in teaching, research, and administration, and 24 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 Technology, 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 includes Keene State College, Plymouth State College, and the Merrimack Valley Branch at Manchester. The School of Continuing Studies makes educational opportunities available throughout the state.

The University enrolls more than 10,000 students, has a full-time faculty of 700, and offers 80 undergraduate and 39 graduate programs. The student body includes 1000 graduate students taught by a graduate faculty of over 400.

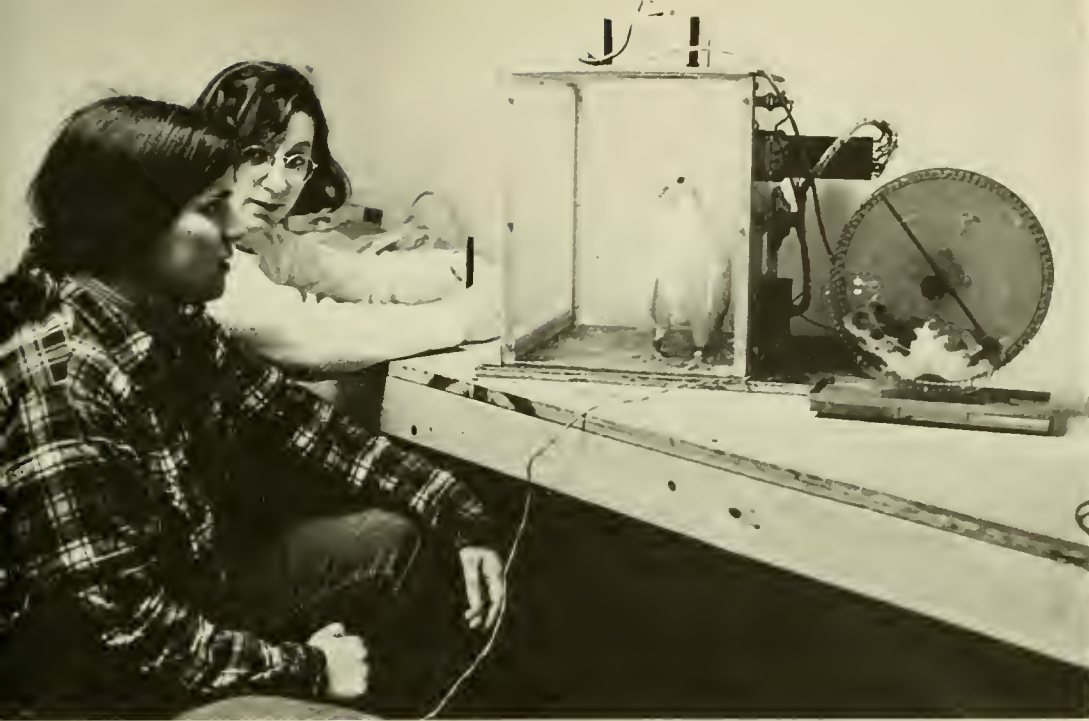
The University of New Hampshire is one of 117 colleges made possible by federal land grants which aided states in developing institutions to serve all the people. The institution was founded as New Hampshire College of Agriculture and Mechanic Arts in 1866 to train young men and women for service to 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.

The programs and services are coordinated by the Office of Recreation and Student Activities, located in the Memorial Union.

Services include a reception area—visitors' information center, the University Ticket Office, and a scheduling office for room and facility reservations. An optional recreation pass may be purchased individually and for families.

Recreational activities are organized in three interrelated programs: men's and women's intramural sports, club sports, and leisure-time activities.

Men's intramurals range from golf, tennis, and touch football in the fall to ice hockey and water polo in the winter, and cycling and soccer in the spring. Women's intramurals include powder-puff football, badminton, basketball, bowling, soccer, softball, and tennis.

The club sports program offers instruction as well as competition with other college clubs in New England. Rugby, sailing, trap and skeet, and water polo are among the 24 club sports.

Informal participation in swimming, exercising and jogging, tennis, ice skating, gymnastics, and field sports is available at Mendums Pond, Snively Arena, and the Field House.

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, and offices for student organizations, and provides facilities for student film services.

The Sidore Series brings provocative, well-known speakers and experimental programs throughout the year. The Blue and White Series is host to leading con-

cert artists, and the Allied Arts Series provides a varied program of drama, music, and dance. Colloquy lecturers discuss academic, political, and social issues.

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.

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. Students may work at the station on a volunteer basis.

## 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

**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, and maintains a mailing list of students visiting or corresponding with the office who ask for specific help in locating suitable accommodations.

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 Off-Campus Housing Office is located in Stoke Hall, open Monday through Friday, 8:00 a.m. to 4:30 p.m.



**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 Head Resident, Apartment 9-F, Forest Park, Durham, N.H. 03824.

**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 \$700 per student per academic year (September-June), 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.

**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.

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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.

The University Dining Service also operates a snack bar at the Memorial Union where ala carte meals may be purchased. Students are encouraged to thoroughly investigate the dining possibilities because there are limited cooking facilities in Babcock House and none are available in individual rooms.

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## Counseling and Health Services

The University Health Service, located in Hood House, contains a well-equipped outpatient 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.

The Counseling and Testing Center, 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**

The Career Planning and Placement Service helps students to obtain permanent employment upon graduation from the University. Their 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 on the second floor of Huddleston Hall.

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### **Campus Minister and Churches**

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; and Protestant, Catholic, and Episcopal churches are located in Durham.

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### **The Alumni Association**

All recipients of a graduate degree from the University are considered members of the Alumni Association. The Association organizes alumni activities and other social and educational programs on and off the campus. *The New Hampshire Alumnus* contains news of the University, students, faculty, and alumni; and some departments also continue to inform their alumni on a regular basis.

# Departmental Requirements and Course Descriptions

## Animal Sciences (17)

**Chairman:** W. C. Skoglund

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

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

**ASSISTANT PROFESSORS:** Frank Repka, Edward Squires, Thomas Wight

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 his graduate courses and thesis. We encourage all students to obtain teaching as well as research experience during their graduate study.

### 701. PHYSIOLOGY OF REPRODUCTION

A study of physiology, embryology, endocrinology, reproduction, and lactation in domestic animals. Staff. 3 lectures; 1 laboratory; 4 credits.

### 705. A REVIEW OF ANIMAL SCIENCE

The principles and practices relating to the feeding, breeding, selection, and management of beef cattle, horses, sheep, and swine. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

### 706. A REVIEW OF DAIRY SCIENCE

Subject matter covering the principles and practices relating to the latest information on dairy cattle breeding, feeding, and management, and the processing and marketing of milk and its products. For teachers of vocational agriculture and other students with the permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

### 707. A REVIEW OF POULTRY SCIENCE

The principles and practices relating to the latest information on poultry breeding, feeding, diseases, and management. For teachers of vocational agriculture and other students with the

permission of their advisers. Staff. (Summer Session only.) Two hours daily, lecture and laboratory; 2 credits.

### 709. BIOCHEMISTRY OF NUTRITION

An in depth study of the intermediary metabolism of nutrients with emphasis on energy metabolism. Coverage includes transport mechanisms; biological oxidations; interrelationships of carbohydrate, fat and protein metabolism in normal and abnormal nutritional states; obesity; and control of hunger and appetite. (Also offered as Home Economics 709.) Mr. Repka. 3 lectures; 1 laboratory; 4 credits.

### 710. RUMINANT NUTRITION

Basic ruminant nutrition and feeding management, including the feeding of young ruminants, with the objective of economical milk production. Mr. Holter. 3 lectures; 1 laboratory; 4 credits.

### 711. COMPARATIVE ANIMAL GENETICS

Consideration of how heredity affects domesticated animals, poultry, other mammals, and fish. Emphasis will be at the level of the organism, but the population, quantitative inheritance, principles of selection, and genetics of resistance to disease will be studied. Statistical and experimental techniques will be discussed. Mr. Collins. Prerequisite: 4 credits of genetics or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

### 712. ANIMAL BREEDING AND IMPROVEMENT

Principles of population genetics and selection with emphasis on the application of these principles to effect genetic improvement in dairy cattle, livestock, and horses. Prerequisite: Animal Genetics 711. Mr. Fairchild. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1975-76.)

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

1. **Genetics:** Mr. Gerald Smith, Mr. Collins, Mr. Fairchild.
2. **Nutrition:** Mr. Gerald Smith, Mr. Ringrose, Mr. Repka, Mr. Holter.
3. **Management:** Mr. Skoglund, Mr. Gerald Smith, Mr. Fairchild.
4. **Diseases:** Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. Samuel Smith.
5. **Products:** Mr. Gerald Smith.
6. **Light Horsemanship:** Ms. Briggs, Mr. O'Connor, Mr. Squires.
7. **Physiology:** Mr. Squires, Mr. Wight.

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. Hours to be arranged. 2 credits. May be repeated.

# Biochemistry

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## 801. ADVANCED STUDIES IN ANIMAL BREEDING

Independent study and research on modern breeding methods and newer systems of selection for quantitative traits. Prerequisite: Animal Science 712. Mr. Collins, Mr. Fairchild, Mr. G.L. Smith. Hours to be arranged. 3 credits.

## 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 lectures; 1 laboratory; 4 credits.

## 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 credits (Alternate years; offered in 1974-75.)

## 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. Mr. Dunlop, Mr. Strout, and Mr. Corbett. Prerequisite: Animal Science 612 or the equivalent. 3 credits.

## 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. Mr. Dunlop and Mr. Strout. Prerequisite: histology or the equivalent. 3 credits.

## 809. ADVANCED POULTRY NUTRITION

Metabolism and the physiology of digestion with emphasis on nutrient needs and deficiency diseases of poultry. Analysis of recent experimental research and current feed problems. Mr. Ringrose. 3 credits.

## 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. Ringrose. 2 lectures; 1 laboratory; 4 credits.

## 812. QUANTITATIVE GENETICS AND SELECTION

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prerequisite: 1 course each in genetics

and statistics. 3 credits. (Alternate years; not offered 1974-75.)

## 851. CELL CULTURE

A consideration of the theory and principles fundamental to the culture 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. Biggs Haugstad. Prerequisite: Microbiology 503, General Microbiology, and permission of instructor. (Also offered as Microbiology 851.) 2 lectures, laboratory hours to be arranged; 4 credits.

## 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. Mr. Wight. Prerequisite: biochemistry, physiology, and vertebrate anatomy or permission of instructor. 3 lectures; 4 credits.

## 897-898. ANIMAL SCIENCE SEMINAR

A survey of recent literature and research in the animal sciences. Staff. 1 credit. May be repeated.

## 899. THESIS

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

# Biochemistry (18)

**Chairman:** Edward J. Herbst

**PROFESSORS:** Donald M. Green, Edward J. Herbst, Miyoshi Ikawa, Douglas C. Routley, 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, plant biochemistry, 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, physiology, advanced microbiology, and genetics are usually recommended.

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

An introduction to the general principles of biochemistry. Mr. Ikawa. Prerequisite: elementary organic chemistry. 3 lectures; 1 laboratory; 4 credits.

## 656. PHYSIOLOGICAL CHEMISTRY AND NUTRITION

An introductory biochemistry course with emphasis on human physiological chemistry and nutrition. The laboratory includes a study of procedures basic to chemical methods used in medical diagnostic work. Mr. Teeri. Prerequisite: satisfactory preparation in organic chemistry. 3 lectures; 1 laboratory; 4 credits.

## 702. COMPARATIVE MARINE BIOCHEMISTRY

The nutrition, metabolism, and composition of marine organisms. Special aspects such as pigments, toxins, hormones, and luminescence will also be considered. Mr. Ikawa. Prerequisite: Biochemistry 601 or equivalent. 2 lectures; 2 credits.

## 722. NEUROCHEMISTRY

A study of those aspects of biochemistry unique to the nervous system. Among the topics to be considered are: metabolism; alterations in normal brain chemistry produced by chemicals, drugs, nutrition, memory and learning; and pathological changes in chemistry. Prerequisite: a course in organic chemistry. A course in biochemistry will be helpful but is not a prerequisite. Mr. Stewart. 4 credits. (Alternate years; offered in 1975-76.)

## 751. PRINCIPLES OF BIOCHEMISTRY

The fundamental principles of biochemistry with emphasis on the chemistry, metabolism, and biological function of nucleic acids, proteins, carbohydrates, and lipids. Mr. Klippenstein and Mr. Stewart. Prerequisite: one year of organic chemistry or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 752. TOPICS IN BIOCHEMISTRY

A detailed consideration of metabolism and of current developments in biochemistry. Staff and guest lecturers. Prerequisite: Biochemistry 751. 2 lectures; 2 credits.

## 760. ENZYME CHEMISTRY

The structure, properties, and function of enzymes; the kinetics and mechanisms of enzyme-catalyzed reactions; and the methods used in purification, characterization, and assay of enzymes. Mr. Klippenstein. Prerequisite: a course in general biochemistry. 3 lectures; 1 laboratory; 4 credits. (Not offered in 1974-75.)

## 762. PLANT METABOLISM

The function, occurrence, synthesis, and degradation of plant constituents. Emphasis is placed on respiration and photosynthesis and the metabolism of nitrogenous and aromatic compounds. Biochemical mechanisms such as those involved in seed dormancy, fruit ripening, and disease resistance are discussed in relation to their roles in plant survival. Mr. Routley. Prerequisite: Biochemistry 751 or equivalent. 2 or 4 credits.

## 770. BIOCHEMICAL GENETICS

The biochemical mechanisms of storage, replication, transmission, transcription, recombination, mutation, and expression of genetic information by cells and viruses. Mr. Green. Prerequisite: Biochemistry 751 or permission of instructor. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1975-76.)

# Biology

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## 781. THE NUCLEIC ACIDS

The chemistry and metabolism of the nucleic acids: molecular structures, purification and separation procedures, synthesis and biosynthesis, and the biological functions of the nucleic acids. Mr. Herbst. Prerequisite: organic chemistry and biochemistry. 3 lectures; 3 credits.

## 795-796. INVESTIGATIONS IN BIOCHEMISTRY

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

## 811. BIOCHEMISTRY OF LIPIDS

The chemistry, metabolism, and function of lipids. Mr. Smith. Prerequisite: Biochemistry 751 or equivalent. 2 credits.

## 832. BIOCHEMISTRY OF CARBOHYDRATES

The chemistry, metabolism, and functions of carbohydrates. Emphasis will be placed on polysaccharides, glycoproteins, and the nature of cell surfaces. Mr. Ikawa. Prerequisite: Biochemistry 751 or equivalent. 2 lectures; 2 credits. (Alternate years; offered in 1974-75.)

## 842. BIOCHEMICAL REGULATORY MECHANISMS

The non-replicative functions of DNA will be considered. The topics to be covered are: transcriptional and translational control of protein synthesis; regulation of the quantity of protein by control of rates of synthesis and degradation; hormonal control of metabolism; control of metabolic pathways by allosteric enzymes and repression. Mr. Stewart. Prerequisite: a course in biochemistry. 3 lectures; 3 credits. (Alternate years; offered in 1974-75.)

## 850. PHYSICAL BIOCHEMISTRY

The physical chemistry of biological molecules with emphasis on the structure and interactions of proteins. Included will be a consideration of the physical methods commonly used in the study of proteins and nucleic acids. Mr. Klippenstein. Prerequisite: physical chemistry and Biochemistry 751 or equivalent. 2 lectures; 2 credits. (Alternate years; offered in 1975-76.)

## 852. ADVANCED BIOCHEMISTRY LABORATORY

Application of chemical and physical techniques to the purification and characterization of proteins and nucleic acids. To be taken in conjunction with Biochemistry 850. Mr. Klippenstein. 2 laboratories; 2 credits. (Alternate years; offered in 1975-76.)

## 897, 898. BIOCHEMISTRY SEMINAR

Presentation and discussion of recent investigations. Mr.

Herbst and staff. Prerequisite: permission of the department chairman. 0 credit.

## 899. MASTER OF SCIENCE THESIS

To be arranged. 6-10 credits.

## 999. DOCTORAL RESEARCH

## Biology:-Intercollege Biological Sciences Organization (60)

**Chairman:** James A. Stewart

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 pathology.

### 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 required advanced, in-breadth training in the biological sciences, or for those who wish to prepare for junior or community college teaching.

### MASTER OF SCIENCE FOR TEACHERS (MST)

This program is designed to provide experienced and/or certified secondary school teachers with an opportunity to update and expand their knowledge of biology. Courses are chosen from the participating biological science disciplines in consultation with the graduate student's adviser.

Inquiries concerning the requirements for these programs should be addressed to the Chairman of the Intercollege Biological Sciences Organization.

See course listings in the departments of Animal Sciences, Biochemistry, Botany and Plant Pathology, Microbiology, I.N.E.R., Plant Science, Zoology, and the Interdepartmental Genetics Program, for offerings.

### Botany and Plant Pathology (19)

**Acting Chairman:** Robert Blanchard

**PROFESSORS:** Albion Hodgdon, Avery Rich, Richard Schreiber

**ADJUNCT PROFESSOR:** Alex Shigo

**ASSOCIATE PROFESSOR:** Arthur Mathieson

**ASSISTANT PROFESSORS:** Alan Baker, Linn Bogle, Robert Blanchard, May Biggs Haugstad, Russell Kinerson, William MacHardy

**ADJUNCT ASSISTANT PROFESSOR:** Terry Tattar

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.

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, Ms. Biggs Haugstad; Plant Ecology, Mr. Kinerson, Systematic Botany, Mr. Hodgdon; Phycology, Marine-Freshwater, Mr. Mathieson, Mr. Baker; Plant Pathology, Mr. Rich, Mr. Blanchard, Mr. MacHardy, Mr. Shigo, and Mr. Tattar; Plant Morphology and Anatomy, Mr. Bogle; Mycology, Mr. Blanchard; Cell Biology, Mr. Schreiber and Ms. Biggs Haugstad.

#### 606. PLANT PHYSIOLOGY

An introduction to the function of higher plants with an emphasis on water relations, metabolism, growth and development. Ms. Biggs Haugstad. Prerequisite: Botany 411, 503

or Plant Science 421 and one year of chemistry or permission of the instructor. 3 lectures; 1 laboratory; 4 credits.

#### 717. GENERAL LIMNOLOGY

An introduction to the special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Emphasis on factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prerequisite: Biology 541, General Ecology, or equivalent. 4 credits.

#### 719. FIELD LIMNOLOGY

Principles of freshwater ecology are examined through laboratory exercises dealing with a variety of freshwater habitats. Stress placed on the methods used to study freshwater lakes and interpretation of data. Includes a seminar series and occasional Saturday field trips. Prerequisites: Present or prior enrollment in Botany 717, Zoology 717, General Limnology, or equivalent, and permission of instructor. 3 credits.

#### 721. FRESHWATER PHYCOLOGY

Identification, classification, and life histories of the major general groups of freshwater algae. Periodic field trips will be scheduled throughout the semester. Mr. Baker. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits.

#### 722. MARINE PHYCOLOGY

Identification, classification, ecology, and life histories of the major groups of marine algae. Particular emphasis will be placed upon the benthonic, marine algae of New England. Laboratories will include field trips during the latter portion of the course. Mr. Mathieson. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits.

#### 723. MARINE ALGAL ECOLOGY

The distribution, abundance, and growth of benthonic marine algae in relation to their environment (chemical, physical, and biological). The students will be expected to attend regular, planned field trips and to conduct an independent research project. Mr. Mathieson. Prerequisite: Botany 722, Zoology 715, or permission of the instructor. 2 lectures; 1 laboratory, and field trips; 4 credits. (Alternate years; offered in 1974-75.)

#### 724. FRESHWATER ALGAL ECOLOGY

A survey of freshwater algal habitats, and the principles prerequisite to understanding man's impact on algal communities of lakes and streams. Winter and spring field problems will be carried out. Mr. Baker. Prerequisite: Botany 721 or permission of the instructor. 2 lectures; 2 laboratories; 4 credits.

# Botany and Plant Pathology

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## (727.) INTRODUCTION TO MARINE PHYTOPLANKTON

A study of the taxonomy and life histories of marine phytoplankton from fresh and preserved marine plankton collections. Cultural techniques and current methods for assessing standing crop and productivity will be studied. Staff. 2 lectures; 2 laboratories; 4 credits. (Alternate years; not offered in 1974-75.)

## 728. MARINE PHYTOPLANKTON ECOLOGY

Study of spatial and temporal distribution of phytoplankton populations in oceans and estuaries with emphasis on interactions with the physical, chemical, and biological aspects of their environment. Laboratories will cover methods of collecting and evaluating phytoplankton populations. Staff. 2 lectures; 2 laboratories; 4 credits.

## 732. CELL BIOLOGY

The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Schreiber. Prerequisite: one year each of the biological sciences and of chemistry. 3 lectures; 1 seminar; 4 credits.

## 735. CELL PHYSIOLOGY (PLANT)

The integration of the molecular nature of structure with the functions of living cells. The emphasis is on algal cells. Ms. Biggs Haugstad. Prerequisites: one year general chemistry and one year of biological sciences; or permission of instructor. 2 lectures; 2 laboratories; 4 credits.

## 741. ECOSYSTEM ANALYSIS

Description of ecosystems with respect to community components, ecosystem development, and biogeochemical cycles. Methods of analysis and interpretation of field data. Mr. Kinerson. Prerequisite: Biology 641, General Ecology, or permission of instructor. 1 lecture; 1 laboratory; 1 colloquium; 4 credits.

## 742. PHYSIOLOGICAL ECOLOGY

The physiological basis of plant-environment interactions will be considered for cellular, whole-plant, and population processes. Biometeorology, physiological adaptation and variation, evolution of ecotypes, growth and reproductive phenomena, as well as mathematical simulation of plant processes will be included. Mr. Kinerson. Prerequisite: Botany 606 or permission of instructor. 1 lecture; 1 laboratory; 1 colloquium; 4 credits.

## 747. AQUATIC HIGHER PLANTS

A survey of flowering plants, fern relatives, and Bryophytes found in and about bodies of water in northeastern United States. Extensive field work, preparation techniques, representative collections, herbarium work, lectures, and discussions. Mrs. Hodgdon. Prerequisite: Botany 566. 1 lecture; 1 colloquium; 1 half-day laboratory; 4 credits. (Alternate years; offered in 1974-75.)

## 751. PLANT PATHOLOGY

The nature of disease in plants; the symptomatology, etiology, and classification of plant diseases. Mr. Rich. Prerequisite: Botany 411 or Botany 503, or equivalent. 2 lectures; 2 laboratories; 4 credits.

## 752. MYCOLOGY

Studies of the parasitic and saprophytic fungi, their growth, reproduction, and identification. Living specimens from all groups will be examined. Techniques in preparing pure cultures will be stressed. Mr. Blanchard. 2 lectures; 2 laboratories; 4 credits. (Alternate years; not offered in 1974-75.)

## 753. FOREST PATHOLOGY

Forest and shade-tree diseases; principles, etiology, epidemiology, and control. Mr. Blanchard. Prerequisite: Botany 411 or Botany 503, or equivalent. 2 lectures; 2 laboratories; 4 credits.

## 754. PRINCIPLES OF PLANT DISEASE CONTROL

Exclusion, eradication, protection, and immunization, and the specific practical methods used to control plant diseases. Mr. MacHardy. Prerequisite: Botany 751 or 753. 1 lecture; 2 laboratories; 4 credits. (Alternate years; not offered in 1974-75.)

## 758. PLANT ANATOMY

The anatomy of vascular plants with special emphasis upon tissue development and structure. Mr. Bogle. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. (Alternate years; offered in 1974-75.)

## 762. MORPHOLOGY OF THE VASCULAR PLANTS

The life histories and evolution of the extinct and living vascular plants, including comparisons of general structure and sexual organs. Mr. Bogle. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. (Alternate years; not offered in 1974-75.)



# Botany and Plant Pathology

## 764. MICROTECHNIQUE

A methods course in embedding, sectioning, and staining plant tissues, and an introduction to microscopy. Mr. Bogle. Prerequisite: permission of instructor. 2 lectures; 4 hours of laboratory; 4 credits. (Alternate years; offered in 1974-75.)

## 767. ADVANCED SYSTEMATIC BOTANY

The principles and rules of plant classification and nomenclature; study of plant families, field and herbarium work. Mr. Hodgdon. Prerequisite: Botany 566. 1 lecture; 1 colloquium; 1 laboratory (full afternoon); 4 credits. (Alternate years; not offered in 1974-75.)

## 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) PHYCOLOGY, 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 or 4 credits.

## 799. BOTANY SEMINAR

Presentation and discussion of oral reports on research with practice in use of visual aids. Participation by all resident departmental majors. Botany Club in charge. 1 hour session weekly. 0 credit.

## 805. ADVANCED PLANT PHYSIOLOGY

Plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, and growth regulator effects. Ms. Biggs Haugstad. Prerequisite: Botany 606 or equivalent, or adequate preparation in the physical sciences. Conferences; laboratory; assigned reading; 3 or 4 credits. (Alternate years; not offered in 1974-75.)

## 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: Botany 722 or its equivalent. 4 credits. (Alternate years; not offered in 1974-75.)

## 830. MORPHOGENESIS

The study of form and development as affected by internal and external factors. Mr. Bogle. Prerequisite: Botany 758 and 762. 2 recitations of 2 hours each. 4 credits. (Alternate years; not offered in 1974-75.)

## 843. THE PLANT AND THE MICROCLIMATE

This course offers a physical approach to the study of productivity, water-relations, and the distribution of individual plants and plant communities. Soil and atmospheric physics will be presented to provide the student with a working knowledge of the relationships between the physical environment and the plant world. Laboratories will provide practical experience with instrument design, calibration, and use for measurement of plant and environmental factors. Mr. Kinerston. Prerequisite: permission of instructor. 3 lectures; 1 laboratory (2 hours); 4 credits. (Alternate years, offered in 1974-75.)

## 851. CELL CULTURE

A consideration of the theory and principles fundamental to the culture 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. Biggs Haugstad. Prerequisite: Microbiology 503, General Microbiology, and permission of instructor. (Also offered as Microbiology 851 and Animal Science 851.) 2 lectures; laboratory hours arranged; 4 credits.

## 852. METHODS IN MYCOLOGY

Methods and techniques utilized in various aspects of mycological research. Preparation of media; culture techniques for isolation and growth; maintenance of stock cultures; cytochemical tests; and controlled development of representative species in the three major groups of fungi, fungal physiology, and ultrastructural techniques will be stressed. Mr. Blanchard. Prerequisite: Botany 752 or permission of the instructor. 2 lectures; open laboratory; 4 credits. (Alternate years; offered in 1974-75.)

## 853. ADVANCED PLANT PATHOLOGY

Advanced theories and methods in plant pathology. Mr. MacHardy. Prerequisite: Botany 751 or 753 and permission of instructor. Assigned reading; conferences; laboratory; 4 credits. (Alternate years; offered in 1974-75.)

## 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. Mr. Hodgdon. Prerequisite: permission of instructor. 1 lecture; 1 colloquium of 2 hours; field trips; 4 credits. (Alternate years; not offered in 1974-75.)

## Business Administration

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**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) PHYCOLOGY, 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 credits.

**899. MASTER OF SCIENCE THESIS**

6-10 credits.

**999. DOCTORAL DISSERTATION**

## Business Administration (30)

**Director of M.B.A. Programs:** William E. Wetzel, Jr.

**PROFESSORS:** Robert F. Barlow, John A. Beckett, Jan E. Clee, Stephen L. Fink, Herman Gadon, John L. Korbel, Dwight R. Ladd, Donald C. Marschner, Samuel R. Reid, Robin D. Willits, Dwayne E. Wrightsman

**ASSOCIATE PROFESSORS:** Allan J. Braff, Allan R. Cohen, James O. Horriang, R. Stephen Jenks, Richard L. Mills, Linda G. Sprague, William E. Wetzel, Jr.

**ASSISTANT PROFESSORS:** Fred Kaen, George Misoulis

**INSTRUCTOR:** 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 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 seeks to foster 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 Admission Test for Graduate Study in Business (ATGSB) given by the Educational Testing Service. Details

concerning the dates and locations for these examinations may be obtained from Educational Testing Service, Box 966, Princeton, New Jersey 08540.

The Whittemore School welcomes applicants with an above-average academic record in any undergraduate speciality 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 relevance to 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 16 four-credit courses requiring two years of study which can be started only in the fall semester. During the first year, eight required courses in the basic disciplines (quantitative analysis, economics, and behavioral science) and the functional areas of management (accounting, marketing, operations management, and financial management) are integrated into an overall study of the process of administration.

The second year of the day program continues the emphasis on overall management by requiring all students to complete the integrating course, Business Policy. Special attention is also given to the study of the modern corporation as a partly economic, partly legal, and partly social organization by requiring all students to complete the course, Conceptual Foundations of Business. In addition, with the help of a faculty adviser, the student will select the equivalent of six four-credit elective courses with some concentration in an area of special interest. Students are encouraged to select appropriate graduate-level courses offered by other colleges of the University as well as by the Whittemore School.

The evening MBA program involves completion of 16 four-credit courses offered in an integrated sequence over eight trimesters. The evening program may be begun only in the winter trimester and, because of the cumulative nature of the program, students must 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.

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

Mathematical programming, game theory, inventory, queuing and scheduling problems, dynamic programming. 4 credits.

## 711. CORPORATIONS

The role of the modern corporation in the economy. Emphasis upon structure of the corporation, the corporate system, combinations, and concentration. Prerequisite: Economics 402. 4 credits.

## 712. ORGANIZATIONAL CHANGE

Examination of the process of change in organizations. Consideration of change strategies, the role of the change agent, and his relation to the client system. The bases of resistance to change and the problems encountered by internal and external change agents. Readings include theoretical material on influence, attitude change, and organizational change. Prerequisite: permission of instructor. 4 credits.

## 713, (713.) INTERPERSONAL AND GROUP DYNAMICS

Intensive experiential study of the dynamics of small groups through the use of the class itself as a Laboratory Study Group. Students examine their own behavior and its effects on others through use of the Laboratory Training Group (T-group) as the major learning tool. The course develops both conceptual ability and behavioral skill in this area. Prerequisite: permission of instructor. 4 credits.

## 717. ADVANCED FINANCIAL ACCOUNTING

Accounting theory and practice as they contribute to the significance and limitations of the financial statements by which business communicates financial status to interested outsiders. Prerequisite: permission of instructor. 4 credits.

## 718. COST AND MANAGEMENT

The effective use of cost accounting, cost analysis, and budgeting in planning and controlling operations. Topics considered include analysis of cost behavior, direct and absorption costing, cost-price-volume relationships, distribution costs, transfer pricing, and capital-expenditure analysis. 4 credits.

## 730. INVESTMENT ANALYSIS

An evaluation of capital markets and of analytical techniques useful for security analysis. The following subjects will be covered: securities characteristics, market institutions, yield structure, price-change patterns, intrinsic value analysis, investment timing, and portfolio management. Lectures, outside readings, and security-analysis research projects are the main tools of the course. Prerequisite: some previous work in financial accounting would be extremely helpful. 4 credits.

## 732. EXPLORATIONS IN ENTREPRENEURIAL MANAGEMENT

The past and probable future role of the entrepreneur in the economic and social development of the U.S. is examined. Emphasis is placed upon differences between entrepreneurial and administrative management. Topics include the mythology of the "American Dream," the entrepreneur as a change agent, entrepreneurial motivation and behavior patterns, the venture-capital markets, and the role of the entrepreneur in non-profit institutions. Prerequisite: permission of instructor. 4 credits.

## 741. TRANSPORTATION

The wide range of problems surrounding the American transportation system. The basic economic structure of the transportation industries with particular emphasis on competition among the several modes. Such public policy questions as merger of transportation enterprises and cost-benefit analysis of transportation facilities are considered. While principal emphasis in the course is on freight transportation, the problems of passenger transportation, especially in urban areas, are discussed. Limited attention is given to distribution as a specific function of business enterprise. Lectures and discussions of cases. Two or three short papers and a term paper are required. 4 credits.

## 747, (747.) FEDERAL AND STATE TAXATION

Current federal income, estate, and gift taxes and their impact on corporations, partnerships, and individuals. Prerequisite: permission of the instructor. 4 credits.

## 750. MARKETING MANAGEMENT

The practical application of the theories taught in Business Administration 808. Topics covered include the planning, organization, and control of marketing activities in large corporations and in small business, with special emphasis on new-product planning and development; laboratory, field, and market testing; pricing policies; selection of channels of distribution; brand management; and the interrelationships among marketing, production, and finance. Principles which underlie sound policy formulation and decision making are established through the analysis of real-life cases, several of which are based upon current marketing problems of nearby New Hampshire firms. Prerequisite: a basic marketing course. 4 credits.

## 751. ADVERTISING AND PROMOTION

A theory of promotion: how the modern firm acts to obtain maximum efficiency and effectiveness from the use of the major tools of marketing communication (advertising, personal selling, sales promotion, direct-mail merchandising, publicity), as seen from the point of view of the marketing manager. Some emphasis is also placed upon ethical and moral

## Business Administration

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problems. The course is built upon lectures, classroom discussions, some creative research, and weekly cases analyses. 4 credits.

### 752. MARKETING RESEARCH

Marketing research as a basis of formulating marketing policies and strategy. Topics include research design, methods of collecting data, planning the investigation, sampling methods, motivation research, advertising research, and consumer research. 4 credits.

### 754. CONSUMER BEHAVIOR

The consumer-firm relationship studied in terms of concepts drawn from contemporary social-science findings, particularly small-group studies, as related to present and prospective marketing activities of a business organization. 4 credits.

### 755. ADVANCED FINANCIAL MANAGEMENT I

Financial policy of the firm with emphasis on solutions to complex problems of working-capital management. Discussion of abstract models and how they can be modified and applied to concrete situations. Cases may be used. Prerequisite: permission of instructor. 4 credits.

### 756. ADVANCED FINANCIAL MANAGEMENT II

A study of the long-term financial decisions of the firm, with emphasis on solutions to problems of dividend policy, optimum capital structure, and capital budgeting under conditions of uncertainty and risk. Prerequisite: permission of instructor. 4 credits.

### 791. SEMINAR IN ORGANIZATIONS

Investigation by a restricted group of students of specific issues in organization theory and practice. The exact topic will vary from semester to semester as interests develop and opportunities for field study emerge. Prerequisite: permission of instructor. 4 credits.

### 798. SEMINAR IN ADMINISTRATION

Selected topics in the administration of firms, institutions, and organizations; topics to vary from term to term. Prerequisite: consent of adviser and the instructor. Credits to be arranged.

### 801. DATA ANALYSIS FOR DECISION MAKING

The course is designed to acquaint students with the techniques and tools necessary to build and/or manipulate simple quantitative decision models—both mathematical and statistical in nature. Models used most frequently in the management of a firm are introduced and discussed. An ability to work problems

using a time-sharing computer is developed early in the semester. Topics include: descriptive statistics; probability theory; modern statistical decision theory, stimulation, other stochastic, and simple deterministic, management-science models. Prerequisite: college algebra. 4 credits.

### 803. HUMAN BEHAVIOR IN ORGANIZATIONS

To provide students with an understanding of behavioral science concepts and their use in the analysis of interpersonal relationships in organizations and to develop sensitivity to the range of possible human behavior in organizations. 4 credits. (Open to Master of Business Administration students only.)

### 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 credits. (Open to Master of Business Administration students only.)

### 805. ORGANIZATION THEORY FOR MANAGERS

Overall objective is to provide the student with a conceptual framework by which he can effectively diagnose organizations and guide administrative decision-making by understanding organizations as social systems operating within a cultural context. Building upon concepts pertaining to the individual, interpersonal, and small group dynamics as explored in Administration 803, the course takes the overall organization as its unit of analysis. A number of organizational parameters, such as goals, structure, leadership, control, and change management are examined individually and in relation to their impact on one another and on the total organization. (Open to evening Master of Business Administration students only.) 4 credits.

### 806. FINANCIAL MANAGEMENT

Concepts and techniques for determining the need for, the acquisition of, and the management of, financial resources of the business. 4 credits. (Open to full-time Master of Business Administration students only.)

### 807. ECONOMIC ENVIRONMENT OF BUSINESS

To provide an understanding of national economic activity including output, income, employment, and price levels, and to provide familiarity with present knowledge of the determinants of economic growth and fluctuations. 4 credits (Open to full-time Master of Business Administration students only.)

### 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. 4 credits. (Open to full-time Master of Business Administration students only.)

## 810. PRODUCTION MANAGEMENT

Concepts and practices in the planning, supervision, and control of activities concerned with manufacturing the goods and services of the firm. 4 credits. (Open to Master of Business Administration students only.)

## 811. CONCEPTUAL FOUNDATIONS OF BUSINESS

Study of the modern corporation as a partly economic, partly legal, and partly social organization, including examination of widely held views of business and views of businessmen about themselves. 4 credits. (Open to Master of Business Administration students only.)

## 812. 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 credits. (Open to Master of Business Administration students only.)

## 815-816. FINANCIAL REPORTING AND ECONOMIC ANALYSIS FOR MANAGEMENT I AND II

An integrated view of accounting and economic analysis. Objectives are to provide the student with some general models of the firm for planning and reviewing operations and with a wide assortment of analytical techniques for decision making. 815, 4 credits; 816, 2 credits. (Open to full-time Master of Business Administration students only.)

## 821-822. QUANTITATIVE ANALYSIS I AND II

The techniques and tools necessary to build and/or manipulate simple quantitative decision models, both mathematical and statistical in nature; consideration of those models that have been used most often in the management of a firm; development of the facility to work problems using the time-sharing computer. First semester topics: descriptive statistics, probability theory, data generating models, modern statistical decision theory, simulation, simple deterministic and/or stochastic management science models. Second semester topics: differential and integral calculus (theory and application), classical statistical inference, regression analysis, matrix algebra, marketing, production and financial models, the role of models in management information systems. Prerequisites: 821—a good, recent course in college algebra or permission of instructor. (Open to evening Master of Business Administration students only.) 4 credits.

## 827. ENVIRONMENT OF THE FIRM

The socio-political, economic, and legal-institutional environment in which the private enterprise firm functions and plans. (Open to evening Master of Business Administration students only.) 4 credits.

## 835. FINANCIAL ACCOUNTING

A general introduction to the objectives, theories, conventions, and processes for reporting and interpreting the financial status of the business enterprise. Primary emphasis on the usefulness and limitations of accounting data in decision making and in analyses of past performance. (Open to evening Master of Business Administration students only.) 4 credits.

## 836. COST AND CONTROL

Emphasis is on the use of accounting data for planning and control purposes. Topics covered include (1) cost behavior and volume-profit analysis, (2) the use of standard costs and flexible budgets as a means of managerial control, (3) evaluation of management performance and the effect of accounting on human behavior, and (4) relevant cost analysis with special reference to capital budgeting problems. 4 credits. (Open to evening Master of Business Administration students only.)

## 837. ECONOMIC ANALYSIS AND DECISION MAKING

A survey of micro- and macro-economic analysis. The analysis will be designed for business decision-making and business-conditions investigation. 4 credits. (Open to evening Master of Business Administration students only.)

## 848. LAW: USE AND APPLICATION IN BUSINESS

The use and understanding of law as it applies to business judgment 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 credits.

## 861. THE PHILOSOPHY OF MANAGEMENT SCIENCE

A study of management from a systems analysis point of view. 4 credits.

## 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 credits.

# Chemical Engineering

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## Chemical Engineering (46)

**Chairman:** Stephen S.T. Fan

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

**ASSISTANT PROFESSORS:** Steven M. Slater, Robert S. Torrest,  
Gail D. Ulrich

**VISITING PROFESSOR:** Yin-Chao Yen

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 he 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 Doctor of Philosophy program on page 71.

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 high-polymer manufacture, including industrial polymerization methods and equipment design. Laboratory work includes typical polymerization reactions and the physical and chemical testing of various types of plastics and synthetic fibers. 3 lectures; 1 laboratory; 4 credits.

### 712. INTRODUCTION TO NUCLEAR ENGINEERING

The scientific and engineering development of nuclear reactors, including basic binding-energy physics, nuclear stability, radioactivity, the elements of nuclear-reactor theory, and the engineering problems of heat transfer, fluid flow, materials selection, and shielding. This course is intended for any interested seniors and graduate students. 4 credits.

### 713. NUCLEAR CHEMICAL TECHNOLOGY

The design, construction, and operation of nuclear process equipment, including reactors and associated chemical processing facilities, and isotope separations plants. The technology of applied radiation chemistry. Intended primarily for seniors and graduate students. 3 credits.

### 750. INTRODUCTION TO PROCESS SIMULATION AND OPTIMIZATION

Analysis and numerical simulation of controlled chemical systems. Laplace transforms; transient responses; methods for solutions of non-linear equations; simultaneous ordinary differential equations; Runge-Kutta, Crank-Nicolson methods. Steady state optimization: linear programming, classical search techniques. Unsteady state optimization: Pontryagin's maximum principle. 3 lectures; 1 laboratory; 4 credits.

### 752. PROCESS DYNAMICS

A basic treatment of process dynamics, including a study of first- and second-order linear processes and their response to step and sinusoidal driving functions. Graphical analysis of the entire control system is included with special emphasis on the optimum design of a stable system. 4 credits.

### 762. INTRODUCTION TO OPTIMIZATION

Simulation and analysis of chemical systems. Numerical methods of solution. Non-linear equations; simultaneous ordinary differential equations: Runge-Kutta, Crank-Nicolson methods. Steady state optimization: linear programming, classical search techniques, unsteady state optimization: Pontryagin's maximum principle. 4 credits.

### 772. PHYSICOCHEMICAL PROCESSES FOR WATER AND AIR QUALITY CONTROL

The origins and characterization of pollutants. Basic processes in water and air pollution control including filtration, sedimentation, coagulation and flocculation, adsorption, and absorption. Elements of process fundamentals including applied fluid mechanics, mass transfer, and kinetics will be presented. Other topics will be thermal pollution, chemical treatment, oil spills on water, and aeration. 3 lectures; 1 laboratory; 4 credits.

### 813. ADVANCED FLUID MECHANICS

Basic equations describing behavior of static and dynamic fluid systems are derived. The equations of motion are derived and applied to laminar and turbulent flow. Momentum and energy equations are employed to analyze advanced problems associated with flow inside conduits. Flow of compressible fluids and boundary layer phenomena are examined briefly. 3 credits.

## 815. HEAT TRANSFER

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

## 816. DIFFUSIVE MASS TRANSFER

Emphasis on the 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 credits.

## 823. ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS

A discussion of the multicomponent open system from the engineering viewpoint; 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 credits.

## 832. ADVANCED CHEMICAL ENGINEERING KINETICS

Discussion of 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 credits.

## 852. ADVANCED PROCESS DYNAMICS

An advanced treatment of process dynamics, including higher order processes and non-linear processes. Special attention is given to representing a complex process by differential equations, linearizing non-linear elements, and adequately controlling the entire system. 3 credits.

## 890. LITERATURE REPORT

Instruction in the use of the library for chemical engineering research. This course will culminate in the preparation of a literature report on a topic of mutual interest to the student and the chemical engineering faculty. 1 credit.

## 895, 896. GRADUATE INDEPENDENT STUDY

Directed reading or investigation at the advanced level on topics or problems in chemical engineering. 2-4 credits.

## 897, 898. GRADUATE SEMINAR

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

## 899. MASTER'S THESIS

Original investigations in chemical engineering. 1-6 credits.

## Chemistry (47)

**Chairman:** 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

**ASSOCIATE PROFESSORS:** David W. Ellis, Gloria G. Lyle, Colin D. Hubbard, Charles W. Owens, Albert K. Sawyer, J. John Uebel, James H. Weber, Charles M. Wheeler, Jr.

**ASSISTANT PROFESSOR:** N. Dennis Chasteen

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 will also demonstrate to his doctoral committee that he 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 his 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 his doctoral committee.

### Master of Science Degree

Admission to this program is based upon a superior undergraduate average and requires satisfactory work in the usual

# Chemistry

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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 chairman. Persons interested in this degree should confer with him.

## 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 his guidance committee, elects courses in chemistry and in the related disciplines, and writes his dissertation on a research problem appropriate to interdisciplinary treatment. Students interested in these programs should write to the chairman of the department for further information.

## Analytical Chemistry

### 762. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS

A treatment of the theory, instrumentation, and application of methods such as atomic absorption, conductimetry, coulometry, emission spectrography, gas chromatography, polarography, potentiometry, and spectrophotometry to chemical analysis. Prerequisites: Chemistry 406; Chemistry 684 as a prerequisite or concurrently or permission of the instructor. Cannot be used for graduate credit by chemistry students. Undergraduate students must register for Chemistry 763 concurrently. 3 lectures; 3 credits.

### 763. INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS LABORATORY

This course includes the consideration of instrumental design and operation, experimental parameters, error analysis, and the applications of the methods covered in Chemistry 762. Must be taken concurrently with Chemistry 762. 1 laboratory; 2 credits.

### 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 credits.

### 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 credits.

### 832. CHEMICAL INSTRUMENTATION

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

### 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 credits.

## Inorganic Chemistry

### 774. INORGANIC CHEMISTRY

The basic theoretical concepts of modern inorganic chemistry at a moderate level, and their applications to inorganic reactions and compounds. Prerequisite: Chemistry 683; Chemistry 684 pre- or co-requisite; or permission of instructor. (May not be used for graduate credit by chemistry graduate students.) 3 credits.

### 775. INORGANIC CHEMISTRY LABORATORY

Synthesis and characterization of inorganic compounds with an emphasis on techniques not taught in other laboratory courses. Undergraduate students must take Chemistry 774 concurrently. 1 laboratory; 2 credits.

### 803, 804. ADVANCED INORGANIC CHEMISTRY

The basic theoretical concepts necessary for an understanding of modern inorganic chemistry: atomic structure, periodicity, chemical bonding in inorganic compounds, the crystalline state, stereochemistry, redox reactions, acids and bases, elementary coordination chemistry, nonaqueous solvents, inorganic reaction mechanisms, energetics, and ionic equilibria. 3 credits.

### 847. ADVANCED INORGANIC CHEMISTRY

Modern theory applied to spectra, magnetism, kinetics, and thermodynamics of coordination compounds. The formation of and reactions of coordination compounds including catalytic



reactions. Prerequisite: Chemistry 803 or permission of instructor. 3 credits.

## 848. ADVANCED INORGANIC CHEMISTRY

The theory and practice of X-ray diffraction and the determination of crystal structure. Prerequisite: Chemistry 804 or permission of instructor. 3 credits.

## Organic Chemistry

### 651-652. ORGANIC CHEMISTRY

The principal classes of organic compounds, aliphatic and aromatic, with emphasis on class reactions and structural theory. Laboratory exercises in the preparation and purification of selected organic compounds. Prerequisite: Chemistry 404 or 406 or permission of instructor. 3 lectures; 3 credits. Students receiving credit for Chemistry 651-652 may not receive credit for either Chemistry 545 or Chemistry 547-548.

### 653-654. ORGANIC CHEMISTRY LABORATORY

Laboratory exercise to accompany Chemistry 651-652. 1 laboratory; 2 credits. Must be taken concurrently with Chemistry 651-652.

### 755. ADVANCED ORGANIC CHEMISTRY

An advanced survey of methods of synthesis and determination of structure, including stereochemistry, of complex organic compounds. Structural determination will be based on chemical and spectroscopic properties, emphasis being placed on the solution of assigned problems. The laboratory will be devoted to the synthesis and structural determination of complex organic compounds, techniques for the separation and determination of purity of unknown compounds, and the identification of these unknowns by spectroscopy and chemical means. 4 credits, or variable credits for graduate students with the permission of the instructor.

### 801. THEORETICAL ORGANIC CHEMISTRY

The structural theories of organic chemistry, including valence-bond and molecular orbital theories. Emphasis on stereochemistry, including conformational analysis and aromaticity. 3 credits.

### 802. THEORETICAL ORGANIC CHEMISTRY

The mechanistic concepts of organic chemistry, including discussion of theoretical and experimental methods used in the study of reaction mechanisms. 3 credits.

### 811. SYNTHETIC ORGANIC CHEMISTRY

Advanced discussion of heterolytic and homolytic substitution and elimination reactions of the major classes of organic compounds, with emphasis on the synthetic utility of these reactions. Permission of instructor. 3 credits.

### 812. SYNTHETIC ORGANIC CHEMISTRY

Addition, oxidation, and reduction reactions and selected molecular rearrangements, with emphasis on the synthetic applications of these reactions. The synthesis and structure determination of complex organic compounds. Permission of instructor. 3 credits.

### 817, 818. SPECIAL TOPICS IN ORGANIC CHEMISTRY

Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, alkaloids, organic sulfur compounds, and nitrogen heterocycles. 2 or 3 credits.

## 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 lectures; 2 laboratories; 4 credits.

### 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: Mathematics 426 (Calculus II) and physics. Undergraduates must register for Chemistry 685-686 concurrently. 3 credits.

### 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: Mathematics 426 (Calculus II) and physics. Must be taken concurrently with Chemistry 683-684. 2 laboratories; 2 credits.

### 776. ADVANCED PHYSICAL CHEMISTRY

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

### 805, 806. ADVANCED PHYSICAL CHEMISTRY

Wave mechanics and quantum chemistry, spectroscopy, mo-

# Chemistry

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lecular structure; statistical thermodynamics, kinetics, and mechanism. Prerequisite: one year of physical chemistry. 3 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 827, 828. THEORETICAL CHEMISTRY I, II

The modern concepts and mathematical formalism of quantum mechanics with applications to electronic structures of atoms and molecules, spectroscopy, and the solid state. 3 credits.

## 829. THEORETICAL CHEMISTRY III

Statistical mechanics with applications to thermodynamics of non-ideal systems, intermolecular forces, and chemical kinetics. Permission of instructor. 3 credits.

## 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 gas liquid chromatography, data handling, nuclear magnetic resonance, mass spectrometry, elementary electronics, and X-ray. 1-3 credits.

## 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 credits.

## 895, 896. COLLOQUIUM IN CHEMISTRY: (1) INORGANIC CHEMISTRY, (2) ORGANIC CHEMISTRY, (3) THEORETICAL ORGANIC CHEMISTRY, (4) PHYSICAL CHEMISTRY, (5) ANALYTICAL CHEMISTRY

3 credits. Sections of the course may be taken to a total of 12 credits.

## 897, 898. SEMINAR

Presentation and discussion of recent investigations in chemistry. 1 credit.

## 899. THESIS—PROBLEMS IN CHEMISTRY

Conferences, library, and experimental work in some field of chemistry. Staff. Credits 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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: Chemistry 784 or its equivalent. 4 credits.

## 789. ATOMIC AND MOLECULAR STRUCTURE

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

# Civil Engineering (48)

**Chairman:** Robert P. Vreeland

**PROFESSORS:** Victor D. Azzi, J. Harold Zoller  
**ASSOCIATE PROFESSORS:** Louis H. Klotz, Harold E. Langley, Jr., John P. Nielsen, Robert P. Vreeland, Tung-Ming Wang  
**ASSISTANT PROFESSOR:** Paul L. Bishop  
**GRADUATE COORDINATOR:** John P. Nielsen

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 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 nominations by the department chairman, 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 Technology. 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 Technology. 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 71.

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

# Civil Engineering

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and consent of the adviser are required for enrollment in all Civil Engineering graduate courses. With the approval of the department chairman 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

Principles of instrumental and analytical photogrammetry. Theory of conformal mapping and the 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: Civil Engineering 505, Surveying. 3 lectures; 1 laboratory; 4 credits.

## 711. COMMUNITY PLANNING

An introduction to community planning. Social, economic, and physical factors affecting community planning; content and extent of desirable community-planning programs, including purpose and scope; preliminary survey; elements of land planning; the master plan; transportation and circulation systems; street patterns and traffic; motor-vehicle parking; airport sites; public-building sites; parks and recreational facilities; zoning; control of land subdivision; neighborhood and shopping center; housing, legal, financial, and economic problems; and redevelopment of blighted areas. Prerequisite: permission of instructor. 4 lectures; 4 credits.

## 714. CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS

The essential elements and legal requirements of engineering contracts; the 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 lectures; 4 credits.

## 721. PAVEMENT DESIGN

Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prerequisites: Civil Engineering 620 and 665. 3 lectures; 1 laboratory; 4 credits.

## 731. NETWORK PLANNING AND SCHEDULING

The application of Critical Path Methods (CPM) and Project Evaluation Review Technique (PERT) to the design and control of civil engineering projects. 1 lecture; 1 laboratory; 2 credits.

## 732. SYSTEMS ANALYSIS

An analysis of civil engineering projects encompassing social and economic criteria as well as engineering feasibility studies. 1 lecture; 1 laboratory; 2 credits.

## 744. SANITARY ENGINEERING II

The essential elements of water supply and wastewater disposal unit-operations and processes. Prerequisite: Civil Engineering 643. 3 lectures; 1 laboratory; 4 credits.

## 745. HYDROLOGY AND HYDRAULICS

The occurrence and physical effects of water on the earth, including meteorology, ground-water runoff, and stream-flow routing, open channel flow, reservoirs, control works, hydroelectric power, irrigation, drainage, and multipurpose projects. 4 lectures; 4 credits.

## 746. WASTEWATER TREATMENT PLANT DESIGN

A study of the fundamental factors affecting choice of treatment units. Design of the components of a wastewater treatment plant and the preparation of a plan for a particular city that comprises a suitable combination of the units previously designed. Prerequisite: Civil Engineering 744. 3 lectures; 1 design period; 4 credits.

## 747. WATER TREATMENT PLANT DESIGN

Concepts, principles, and theory of water treatment plant design using a water source for a particular city and developing a treatment system for that community. Prerequisite: Civil Engineering 744. 3 lectures; 1 design period; 4 credits.

## 748. SOLID WASTE DISPOSAL

Study of basic concepts and theory of solid waste collection and disposal systems. Design methods involved in disposal system. Prerequisite: Civil Engineering 643. 3 lectures; 1 design period; 4 credits.

## 751. TRANSPORTATION PLANNING

The techniques used to predict the demand for transportation services. The transportation planning process including trip generation, distribution, mode choice, network assignment, and system evaluation. The use of computer models to study transportation facilities in New England. Prerequisite: Civil Engineering 621 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 752. TRAFFIC ENGINEERING

The concepts and techniques used in designing for and controlling traffic flow. Among the topics covered are: traffic control; capacity and volume calculations; parking; highway safety; geometric design; and traffic flow models. The course focuses upon the design aspects and operational characteristics of traffic facilities. Prerequisite: Civil Engineering 621. 4 lectures; 4 credits.

## 753. URBAN AND REGIONAL SYSTEMS ANALYSIS METHODS

The mathematical techniques necessary in the analysis of urban and regional systems. Matrix operations, regression analysis, linear programming, network analysis, factor analysis, and stochastic systems. Emphasis on computer applications to regional systems in New England. Prerequisite: Math 427 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 754. ANALYSIS OF URBAN AND REGIONAL SYSTEMS

The application of analytical techniques to regional systems in New England. Individual or group projects concerned with such systems as migration, transportation, health care, education, recreation, and sanitation. Prerequisite: Civil Engineering 753 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 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 lectures; 4 credits.

## 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. Computations by classical, numerical, and computer applied methods. Prerequisite: Civil Engineering 665, Soil Mechanics. 4 lectures; 4 credits.

## 768. SEEPAGE THROUGH EARTH STRUCTURES

Fundamentals of 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: Civil Engineering 665 and Civil Engineering 642. 2 lectures; 2 credits.

## 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: Civil Engineering 682, Structural Design Concepts. 1 lecture; 1 design period; 2 credits.

## 784. STRUCTURAL ANALYSIS BY MATRIX AND NUMERICAL METHODS

Presentation of a unifying concept of basic structural-analysis theories; introduction to matrix and numerical methods of analysis and their application by linear graph concepts using computers. 3 lectures; 1 design period; 4 credits.

## 790. INELASTIC STRUCTURAL DESIGN

A continuation of modern design theory, ultimate design of reinforced concrete, and plastic analysis of steel structures. 4 lectures; 4 credits.

## 793-794. ADVANCED STRUCTURAL DESIGN I AND II

The design in steel by the elastic theory and in reinforced concrete by the working-stress method of structural elements and connections, using the appropriate controlling specifications. 3 lectures; 1 design period; 4 credits.

## 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 credits.

## 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: Civil Engineering 721. 2-4 credits.

## 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: Civil Engineering 744 and Microbiology 503, General Microbiology, or consent of instructor. 3 lectures; 1 laboratory; 4 credits.

## 856. INDUSTRIAL WASTEWATER TREATMENT

Detailed consideration of the origin, characteristics, and treatment of industrial wastewaters; the theory and application of unit operations unique to the treatment and disposal of industrial wastes. Prerequisite: Civil Engineering 744. 4 lectures; 4 credits.

# Civil Engineering

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## 857. ADVANCED WASTEWATER TREATMENT

Theory, application, and evaluation of new processes and developing techniques in water and wastewater reclamation and reuse. Prerequisite: Civil Engineering 746. 4 lectures; 4 credits.

## 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: Civil Engineering 746 and 856. 2 lectures; 2 laboratories; 4 credits.

## 864. ADVANCED SOIL MECHANICS II

The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, sharing resistance, bearing capacity, settlement, slope stability, earth pressure, and seepage studies. Consent of instructor required for class admission. 4 lectures; 4 credits.

## 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: Civil Engineering 863 or equivalent. 4 lectures; 4 credits.

## 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: Civil Engineering 863 or equivalent. 2-4 credits.

## 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: Civil Engineering 765 and Civil Engineering 863. 2 lectures; 2 credits.

## 881. ADVANCED STRUCTURAL ANALYSIS I

Advanced structural theory and analysis, including multi-story structures, beam columns, frames with variable moment of inertia, continuous trusses and bents, arches and curved frames, stiff rings, and closed frames. 4 lectures; 4 credits.

## 882. ADVANCED STRUCTURAL ANALYSIS II

Advanced treatment, including flexible and axially loaded flexural members, beams with variable cross-section subject to axial loads, suspension bridges and flexible arches, and torsional problems of noncircular sections. 4 lectures; 4 credits.

## 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 lectures; 4 credits.

## 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 lectures; 4 credits.

## 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 lectures; 4 credits.

## 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 lectures; 4 credits.

## 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 lectures; 4 credits.

## 890. TOPICS IN STRUCTURES

Studies of topics of special interest and need of the student in structural design, analysis, and optimization. 2-4 credits.

## 895, 896, 897. CIVIL ENGINEERING PROBLEMS

The study and investigations of problems selected to meet the needs of the students. 2-4 credits.

## 899. MASTER'S THESIS

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

## Earth Sciences (49)

**Chairman:** 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, Theodore C. Loder

**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, and oceanography. A student is expected to have adequate preparation in mathematics and the basic sciences. 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, it is recommended that students 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

The study of igneous and metamorphic rock series; the application of textural, mineralogical, and chemical analysis, and phase rule and phase diagram interpretation to petrogenesis. Mr. Bothner. Prerequisite: Earth Sciences 613, 614 (Mineralogy) or permission of instructor. Labs consist of field study and petrographic analysis. 3 lectures; 1 laboratory; 4 credits.

## 734. APPLIED GEOPHYSICS

Theory and application of gravity, magnetic, seismic, electric, and thermal methods of investigating subsurface geology. Practical fieldwork and use of computers in data analysis. Mr. Birch. Prerequisites: Math 428 (Calculus II) passed or taken concurrently, Earth Science 401 (Principles of Geology I), one year of college physics, or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 741. GEOCHEMISTRY

Applications of thermodynamics to geological processes; geochemical differentiation of the earth; the principles and processes which control the distribution and migration of elements in geological environments. Mr. Gaudette. Prerequisite: Earth Sciences 614, Mineralogy, or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

## 752. CHEMICAL OCEANOGRAPHY

An introduction to the chemistry of the oceans, with emphasis on 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*. Mr. Loder. Prerequisite: permission of instructor. 3 lectures; 1 laboratory (optional); 3 or 4 credits.

## 754. SEDIMENTATION-STRATIGRAPHY

The properties of sediments and sedimentary rocks, with emphasis on lithofacies, biofacies, principles of stratigraphic correlation, and sedimentary tectonics. Mr. Anderson and Mr. Tischler. Prerequisite: Earth Sciences 614, Mineralogy, or permission of instructor. 2 lectures; 1 laboratory; 4 credits.

## 759. GEOLOGICAL OCEANOGRAPHY

Geologic properties of the earth that are unique to the continental shelves and ocean basins. Special emphasis will be placed on submarine geomorphology, eustatic sea level changes, crustal and subcrustal oceanic structure, and the evolution of the ocean basins. Mr. Anderson, Mr. Birch. Prerequisite: Earth Sciences 501, Introduction to Oceanography, and Earth Sciences 754. 2 lectures; 1 discussion group; 1 special project; 4 credits.

## 781. PHYSICAL GEOLOGY

The materials and structures of the earth and the erosive agents that modify them are described in the lectures and are examined and studied in the laboratory and on field trips. This course is for certified elementary or high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing Earth Sciences 401, Principles of Geology I, or equivalent.) 4 credits.

## 782. HISTORICAL GEOLOGY

The history and development of the physical features of the earth and the development of life on the earth. Fossil organisms will be briefly surveyed in the laboratory and the methods of historical geology will be illustrated in the laboratory and on field trips. Prerequisite: Earth Sciences 781 or equivalent. This course is for certified elementary or high school science

## Earth Sciences

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teachers who need an introduction to the earth sciences. (Not available for credit after completing Earth Sciences 402, Principles of Geology II, or equivalent.) 4 credits.

### 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 credits.

### 796. HONORS PROJECT

Independent research projects similar to Earth Sciences 795 for students with 3.0 or better average in Earth Sciences. Staff. 2 or 4 credits.

### 797. GEOLOGY COLLOQUIUM

Study of selected topics in both classical and modern geological thought. Designed for majors. 0 credit. (NLG)

### 813. X-RAY CRYSTALLOGRAPHY

The theory and practice of diffraction of X-rays by crystals; lattices, symmetry, and structure analysis. Mr. Schneer. Prerequisite: Earth Sciences 613, Mineralogy, or Physical Chemistry or equivalent. 3 credits.

### 816. MINERALOGY OF CLAYS

The mineralogic composition of clays; the structure and properties of the clay minerals; origin and mode of occurrence of the clay minerals and clay materials. Prerequisite: permission of instructor. Mr. Gaudette. 3 credits. (Offered alternate years.)

### 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. Mr. Bothner. Prerequisite: graduate standing and permission of instructor. 3 credits. (Offered alternate years.)

### 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. Mr. Bothner. Prerequisite: graduate standing and permission of instructor. 3 credits. (Offered alternate years.)

### 841. ANALYTICAL GEOCHEMISTRY

Introduction to the theory, instrumentation, and applications of analytical methods in Geochemistry. Mr. Gaudette. Prerequisite: permission of the instructor. 3 credits. (Offered alternate years.)

### 856. ESTUARINE AND MARINE SEDIMENTATION

The unique aspects of sedimentation in marine and brackish water environments will be discussed with special emphasis placed on coastal and shelf areas and the factors that control its deposition. Deep sea marine sediment will be examined primarily for non-biogenic components. The course will include completion of a project and preparation of a report suitable for publication. Mr. Anderson. Prerequisite: permission of instructor. 3 credits. (Offered alternate years.)

### 895, 896. TOPICS IN GEOLOGY

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

### 899. EARTH SCIENCES MASTER'S THESIS

6-10 credits.



## Economics (31)

**Director of Graduate Studies:** Kenneth J. Rothwell

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

**ASSOCIATE PROFESSORS:** George W. Betz, Allan J. Braff, William R. Hosek, Richard L. Mills

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

**VISITING ASSOCIATE PROFESSOR:** Lawrence P. Nordell

**ASSISTANT PROFESSORS:** Lawrence P. Cole, Phillip DeVille, Richard Hurd, Robert C. Puth, Heidemarie C. Sherman

### 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.

### Doctor of Philosophy

Admission to this program 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 past academic performance, of which two shall be from those familiar with the applicant's work in his major.

The Ph.D. candidate after admission will be required to demonstrate proficiency in two research tools: 1) a reading knowledge in one foreign language which contains a substantial body of formal economics or is appropriate to an economic research field and 2) demonstrated competence in differential and integral calculus and linear algebra as applied to quantitative economics.

Ph.D. candidacy requires written evidence of proficiency in Economic Theory (including the Evolution of Economic Analysis and Quantitative Economics) and in three other fields of economics (or

two in economics and one approved related field). Successful examination in Economic Theory is to precede the qualifying examination in other fields. In special cases, oral examinations may be required. The dissertation will be followed by an oral defense.

At present time dissertations are confined to the following four fields: 1) International Economics and Economic Development, 2) Labor and Manpower Economics, 3) Industrial Organization, and 4) Regional Economics. Details of the doctoral program can be obtained from the Director of Graduate Economic Studies.

### Master of Arts Degree

Admission to graduate study leading to the degree of Master of Arts is limited to students with a better than average undergraduate record. Candidates for admission are required to take the Graduate Record Examination (both the Aptitude Test and Advanced Test in Economics). The prerequisite for graduate work consists of a minimum of 24 hours of undergraduate study in Economics and related fields of which at least 12 hours shall have been in Economics. In addition, all candidates must either present six hours of undergraduate credit in statistics or mathematics, or take six hours of undergraduate work in statistics or mathematics at the University of New Hampshire without credit, or pass a proficiency test in either field.

The candidate for a master's degree must fulfill the general requirements of the Graduate School and the following major requirements:

1) 32 semester hours of graduate study or 24 semester hours and a thesis: (a) a minimum of 24 semester hours in courses numbered 700 and above, of which 8 hours may be satisfied by an acceptable thesis; at least 12 of these hours, exclusive of the thesis, must be in courses numbered 800 and above; (b) a maximum of 8 semester hours in approved courses numbered 600 and above taken in related disciplines.

2) A course grade of B or better at the graduate level as evidence of proficiency in both micro- and macro-economic analysis. 3) Evidence of proficiency, based upon a written examination, in one of the following major areas: (a) a subset in Quantitative Methods, (b) Labor Economics and Industrial Relations, (c) Public Policy toward Business and Labor, (d) Economic Growth and Stability, (e) International Economy and Economic Development, (f) Resource Development, (g) Economic History, (h) the Evolution of Economic Analysis.

### 711. ECONOMIC FLUCTUATIONS

The study of recurrent movements of prosperity and depression, with emphasis upon causes and public-policy implications. Prerequisite: permission of instructor. 4 credits.

## Economics

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### 720. U.S. ECONOMIC HISTORY

The development of the United States economy from colonial times to the present. Presentation and application of economic models and interpretation of data are stressed. The influence of capital accumulation, industrialization, foreign trade, monetary factors, and government are considered, with peripheral attention to noneconomic factors. Primarily a course in applied economic theory. 4 credits.

### 721. EUROPEAN ECONOMIC HISTORY

The development of Western European and Mediterranean economics from medieval times to the Common Market. Presentation and application of economic models and interpretation of data are stressed. Attention is centered on capital accumulation, technology, trade, industrialization, monetary factors, and the role of government, but the influence of noneconomic factors is discussed where relevant. 4 credits.

### 722. CASE STUDIES IN ECONOMIC DEVELOPMENT

An analysis and evaluation of economic development problems and policies in selected countries. Noneconomic factors important as initial conditions and conditioning influences for the process of economic development are emphasized. Major development-policy areas are studied, and an appraisal of national planning experience and the prospects for regional cooperation is made. 4 credits.

### 725. STATISTICAL THEORY

The theoretical basis of statistical methods; probability, probability distributions, statistical inference, and decisions. Prerequisite: permission of instructor. 4 credits.

### 726. MATHEMATICAL ECONOMICS

An introduction to the principal mathematical techniques and their application in economics. Prerequisite: permission of instructor. 4 credits.

### 727. INTRODUCTION TO ECONOMETRICS

The application of statistics and mathematics to economic problems. The formulation of economic models, their measurement and verification. Prerequisite: Economics 725 or permission of instructor. 4 credits.

### 728. STATISTICAL DECISION MAKING

The application of probability and statistics to decision problems. Special emphasis on the Bayesian approach to decisions under uncertainty. Prerequisite: permission of instructor. 4 credits.

### 735. ADVANCED MONEY AND BANKING

Emphasis on central banking, monetary policy, and monetary theory. Study of current problems and developments in banking. 4 credits.

### 746. INTERNATIONAL FINANCE

The international monetary mechanism. Analysis of private and official international capital flows. Instruments and institutions. The multi-national corporation. Exchange rates, adjustment systems, international liquidity, foreign aid. 4 credits.

### 750. IMPERFECT COMPETITION

Extensive survey of firm behavior in imperfectly competitive market forms, such as monopoly and oligopoly. The implications for price and research performance under such market forms are examined and the relevance of the theoretical arguments are assessed by recourse to appropriate empirical studies. 4 credits.

### 758. MANPOWER AND EDUCATION PLANNING

The flows of human beings within and between the educational and manpower sectors of the economy will be investigated. Such flows will also be related to the flows of goods and services in the industrial sector. Study of the interrelationships of these flows will be directed toward the construction of a computer simulation model for use in tracing the impact throughout the economy of manpower and educational planning decisions. 4 credits.

### 768. SURVEY OF URBAN ECONOMICS

Introduction to the theoretical and empirical bases for investigating urban economy; a discussion of policy alternatives for the problems of poverty, housing, urban renewal, transportation, local fiscal affairs, and pollution. Prerequisite: Economics 605 (Intermediate Economic Analysis) or permission of instructor. 4 credits.

### 798. SEMINAR IN ECONOMIC PROBLEMS

Special topics in Economics. This course may be repeated. Prerequisite: consent of adviser and instructor. 2 or 4 credits.

### 851. HUMAN RELATIONS IN INDUSTRY

Labor-management relations studied as one aspect of human relations; applications of recent research in the behavioral sciences; case studies. 4 credits. (Offered in alternate years.)

### 852. ECONOMICS OF COLLECTIVE BARGAINING

Tools of economic analysis applied to collective bargaining—wages, productivity, seniority rules, job security, package

bargaining. Application to cases. 4 credits. (Offered in alternate years.)

### 855. LABOR MICROECONOMICS

Wage theory under competition, monopoly, monopsony. Productivity, real wages, and labor's share. Wage structure, job evaluation, wage incentive systems, package bargaining. 4 credits. (Offered in alternate years.)

### 856. LABOR MACROECONOMICS

Economic theory applied to labor market problems related to policies for full employment without inflation. 4 credits. (Offered in alternate years.)

### 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 credits.

### 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 credits.

### 861. NATIONAL ECONOMIC PLANNING

Analysis of the functioning of various types of national economic systems. Emphasis on economic planning and development. 4 credits.

### 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 credits.

### 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 credits.

### 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: Economics 873. 4 credits.

### 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 credits.

### 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: Economics 877. 4 credits.

### 891. SEMINAR IN MONETARY THEORY AND POLICY

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

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

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

### 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 credits.

### 895-896. INDEPENDENT STUDY

Selected projects. Staff. 8 credits.

### 899. THESIS

Staff. 8 credits.

### 999. DOCTORAL RESEARCH

Staff.

## Education (61)

**Chairman:** 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, Virginia Ber-eit, John E. Carney, Ellen Corcoran, Ronald P. Curcio, Michael Diamonti, Anne Diller, Sidney Eder, Fred Krieg, Edward J. Lawton, Judith A. Meagher

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

**ADJUNCT ASSISTANT PROFESSORS:** John R. Cavanaugh, Peter Cim-bolic

**GRADUATE COORDINATOR:** David J. Hebert

# Education

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## 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 both the aptitude test and the achievement test in the field selected by the applicant.

## Admission Requirements

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

## Admission Procedures

1. File an application for admission to Graduate School. This application is available directly from the dean of the Graduate School, Social Science Center, University of New Hampshire, Durham, New Hampshire 03824.

2. Transcripts, letters of recommendation, and Graduate Record Examination scores should be sent directly to the dean of the Graduate School.

3. Scores must be submitted for the aptitude tests of the nationally administered Graduate Record Examination. Information regarding the Graduate Record Examination may be obtained by contacting either Educational Testing Services in Princeton, New Jersey, or the Counseling and Testing Center at the University of New Hampshire.

4. Completed applications are reviewed by the Education Department's Admissions Committee which makes a recommendation on admission to the dean of the Graduate School. The applicant is informed of the final decision regarding his application by the dean.

## 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. Each candidate will plan this portion

of his program in terms of his own professional needs and in consultation with his graduate adviser. There is no thesis or examination requirement for the Master of Arts in Teaching.

## Master's Degree Programs in Education

The Department of Education and the Graduate School offer courses in six graduate programs which lead to the Master of Education degree. Some of these programs are also available to part-time students through the Division of Continuing Education.

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

### Administration and Supervision

**Program Information:** Charles Ashley, J. Boynton, Roland Kimball, and Joseph Petroski.

The program is designed for the experienced teacher who seeks to become qualified in the broad area of supervision and administration, grades K-12. Emphasis is placed on the elementary and secondary school principalship and general instructional supervision.

**Required Education Courses** (24 credits): 785, Tests and Measurements; 865, Educational Supervision; 853, Seminar in Curriculum Study; 861, Public School Administration; 863, Seminar in Educational Administration; and 869, Practicum in Educational Administration.

**Electives** (12 credits): The pattern of electives is to be planned with each student in view of the student's background and professional objective. Normally a major portion will be selected from the following Education courses: 864, Personnel and Communication in Educational Organizations; 884, Advanced Human Development; 883, Advanced Psychology of Human Learning; 886, Philosophy of Education; 895, Independent Study in Education; 797, Seminar in Contemporary Educational Problems; 888, Sociology of Education; and from Bus. Adm. 803, Human Behavior in Organizations; Bus. Adm. 713, Interpersonal and Group Dynamics; Sociology 740, Culture Change; and Sociology 770, Culture, Personality, and Society.

**Oral Examination:** The program will conclude with a comprehensive oral examination based upon the thesis prepared by the candidate or with a major research study dealing with a problem in school administration, curriculum, or educational supervision.

### Counseling and Personnel Services

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

The program 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; and

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.

**Required Education Courses:** (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** (12 credits): 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 the departments of Education, Business Administration, Economics, English, History, Home Economics, Mathematics, Political Science, Psychology, and Sociology.

### Early Childhood

**Program Information:** Donald Graves, Deborah Stone.

The master's program in Early Childhood is a 12-month program (July through June) with the objective of preparing participants as Early Childhood Resource Specialists. Upon completion of the program it is expected that one has the competence to assume a role as master teacher, supervisor of an early childhood program, curriculum consultant, in-service teacher-educator, or college level instructor in Early Childhood.

This graduate program is characterized by an emphasis upon the practicum experience coordinated with extensive course work in the academic disciplines.

Participants engage in an intensive summer experience devoted to study of the young child and an analysis of the learning environment appropriate for that child. From September through June the 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 aides from the local community.

Throughout the school year participants 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) and through taking part in frequent Saturday seminars. Additional field experiences are: visits to Toronto, Canada, schools; to Follow Through models; to Montessori Schools; as well as a three-week work experience in British Infants Schools in England.

The production of a monthly Early Childhood Newsletter is a responsibility of those engaged in the program, the provision of

staff development workshops for local school personnel is expected, and the year culminates with the students' participation in the planning and execution of an Early Childhood Conference at the New England Center for Continuing Education.

In this thirty-six credit program, in addition to the continuous active involvement in an Early Childhood Learning Center, regular newsletter contribution, and conference participation, an independent study is a required part of each semester's program. It is anticipated that the independent study will result in papers of significance which will be shared at the Early Childhood Conference.

### Elementary Education

**Program Information:** Virginia Bereit, Edward Lawton, Michael Diamonti.

This program is designed for the classroom teacher who majored in elementary education at the undergraduate level and who desires increased competence as a teacher and professional staff member.

The program is organized around two areas: core requirements and related electives.

The total requirement is for 36 credits, 16 of which are required and 20 of which are electives.

**Required Courses** (16 credits): Education 785, Tests and Measurements; Education 853, Seminar in Curriculum Study; Education 883, Advanced Psychology of Human Learning; and Education 886, Philosophy of Education.

**Electives** (20 credits): Any three Education courses of the following: 734, Children's Literature; 806, Language and Literature in the Elementary School; 807, Survey of Reading; 858, Analysis of Teaching.

Any two Education courses of the following: 763, Instructional Media; 822, Psychological Tests in Personnel Services (Prerequisite: Education 785); 838, Sociology of Education: Social Organization of Schools and Community; 861, Public School Administration; 864, Personnel and Communication in Educational Organizations; 865, Educational Supervision; 881, Methods and Techniques of Educational Research; 888, Sociology of Education: The Cultures of Poverty and Affluence; 895, Independent Study in Education; 797, Seminar in Contemporary Educational Problems; and 899, Thesis.

**Concluding Requirements:** There are three options for the concluding experience:

1. One may elect to take 36 credits and present a set of theses upon which an oral examination is to be taken and satisfactorily passed.

2. One may do a research thesis, taking 28 credits from the above and four credits in 881, Research Problems in Education, plus four credits in 899, Thesis.

3. One may, with the approval of one's adviser, take the 36 hours and a written comprehensive examination. The above program may

## Education

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be substantially modified only with the faculty advisory committee approval.

### Reading

**Program Information:** John Carney, Judith Meagher.

The program for the Master of Education degree with a major in Reading is designed to provide the professional preparation required of the reading specialist. The student will concentrate on the two aspects of the reading program which are consistent with the aims of such services: 1) The improvement of the reading abilities of all the pupils and 2) the prevention, diagnosis, and remediation of reading difficulties.

Within the scope of the program, the following requirements may be satisfied: standards for 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 his individual needs as indicated by his academic and professional backgrounds and his professional objectives.

It is felt that this program totaling 36 credits offers unique experiences for the student who is planning a career as a reading specialist. Course selection will in part depend upon the area of concentration.

**Core Curriculum** (Minimum 12 credits):

Elementary Specialists: 807, Survey of Reading; 808, Diagnostic and Remedial Procedures at the Elementary Level; 809, Practicum in Developmental and Remedial Reading and Language at the Elementary Level.

Secondary Specialists: 810, Reading and Study Skills in the Secondary Schools; 811, Diagnostic and Remedial Procedures at the Secondary Level; 812, Practicum in Developmental and Remedial Reading and Language at the Secondary Level.

**Core Electives** (Minimum 8 credits chosen from the following depending upon area of specialization): 806, Language and Literature in the Elementary School; 807, Survey of Reading; 810, Reading and Study Skills in the Secondary Schools; 814, Seminar in Reading.

**Field Practicum Experience:** This phase of the program is designed to expand the student's competence in areas where the greatest need is felt. This is a highly individualized portion of the program where the student, in consultation with his adviser, plans activities which are most useful to him. (No credit)

**Electives:** The remainder of courses (8-16 credits) are selected from the offerings of the Department of Education in consultation with the adviser. The student will select courses which will satisfy his need for professional and personal development.

### PROGRAM SUMMATION

#### I. Written Comprehensive or Oral Examination—Theses

12 credits—core requirements  
8 credits—core electives  
16 credits—electives  
36 credits total

#### II. Research Thesis

12 credits—core requirements  
8 credits—core electives  
8-12 credits—electives  
4- 8 credits—thesis  
36 credits total

## 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 801-802, Internship (12 credits). (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 & 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.

**Degree Requirements:**

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 801 (6 credits) and Education 802 (6 credits). Six credits of internship may be approved for some MAT candidates who have had Education 831, 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 of 30 credits.
5. Final experience: theses (professional statements and oral examination), research thesis, or project. All 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 (4 credits) and Education 881, Research Problems in Education required for students who have not had advanced research course, (4 credits). These 8 credits may be counted toward the 12 credits of graduate specialization in education.

**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.

**Degree Requirements:**

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 801, (6 credits) and Education 802 (6 credits). (Six credits of internship may be approved for some M.Ed. candidates who have had Education 831 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. Final 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 (4 credits), and Education 881, Research Problems in Education (4 credits), for students who have not had an advanced research course. These 8 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.

## Courses in Developmental Disabilities

The Education Department offers several courses in the area of developmental disabilities which can lead to state certification. Contact Professor Krieg for additional information.

## Certificate of Advanced Graduate Study

### Counseling

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 the 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.

# Education

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## School Administration and Supervision

The program is 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 superintendent, business managers, state department of education personnel, vocational education coordinators, curriculum coordinators, or educational personnel in private organizations.

Applicants for admission must meet the selection criteria established by the University of New Hampshire Graduate School and Department of Education.

A candidate in this program 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 Charles Ashley, associate professor of Education, Morrill Hall, for further details regarding the Certificate of Advanced Graduate Study in Educational Administration and Supervision.

## 700. EDUCATIONAL STRUCTURE AND CHANGE

An area of study providing information on the organization, structure, and function of American schools and on the processes of change in education. Emphasis will be on how successful innovation can be accomplished in classrooms and schools. Included will be options involving field experiences. A number of variable-credit modules will be offered within this area of study. A list of sections to be offered will be available in the Department of Education prior to preregistration. Prerequisite: Education 500, Exploring Teaching, or permission of instructor. Minimum of 4 credits required for teacher certification.

## 701. HUMAN LEARNING AND DEVELOPMENT

The area of study is designed to focus on the development of the individual and an analysis of the learning process. A number of variable-credit modules centering on the theories, research, and implications for education of a specific topic will be offered each semester and in the summer program. A list of sections to be offered will be available in the Department of Education prior to preregistration. Prerequisite: Education 500, Exploring Teaching, or permission of instructor. Minimum of 4 credits required for teacher certification.

## 703. ALTERNATIVE TEACHING MODELS

Basic teaching models which span the spectrum from very teacher-directed to very student-centered will be studied along with those techniques vital to successful use of each model and systems with which to analyze applications of the models and techniques. Models and their associated techniques will be studied in depth and initial steps toward mastery of them taken. Models will be studied through observation of master classroom teachers, observation of exemplary video-tapes, service as aides to master classroom teachers, and seminars. Techniques and analysis systems will be studied through observation of video-tapes, micro-teaching, completion of appropriate self-instruction units, and seminars. A list of sections to be offered will be available in the Department of Education prior to preregistration. Prerequisite: Education 500, Exploring Teaching. Minimum of 4 credits required for teacher certification.

## 705. ALTERNATIVE PERSPECTIVES ON THE NATURE OF EDUCATION

A course designed to help students formulate, develop, and evaluate their own educational principles, standards, and priorities. The course will include an exploration of alternative philosophies of education and an examination of some contemporary educational issues. Enrollment limited to 25 per section. 4 credits.

## 734. CHILDREN'S LITERATURE

A consideration of children's books and methods of using them, with emphasis given to intermediate grades. Practical demonstrations of how to correlate children's books with various special subjects. 4 credits.

## 763. INTRODUCTION TO EDUCATIONAL MEDIA

The role of educational media in the learning process with emphasis on the curricular integration of the materials and equipment commonly available in the school library media



center. The design and implementation of learning systems will provide a framework for the development of individual skills. 4 credits.

## **785. EDUCATIONAL TESTS AND MEASUREMENTS**

An introduction to the theory and practice of educational evaluation. Emphasis is given to uses of test results in classroom teaching and student counseling. Introductory statistical techniques. 4 credits.

## **795, 796. INDEPENDENT STUDY**

Must be approved by appropriate faculty member. 2 or 4 credits per semester. May be repeated to a maximum of 8 credits.

## **797. SEMINAR IN CONTEMPORARY EDUCATIONAL PROBLEMS**

A seminar offered by one or more members of the staff dealing with issues or problems of special contemporary significance. Normally the seminar will focus on a problem which has been the subject of recent special study by the staff member(s). Prerequisite: permission of instructor(s). Variable credit. 1-4 credits per semester. May be repeated for different topics.

## **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. 6 or 12 credits.

## **806. LANGUAGE AND LITERATURE IN THE ELEMENTARY SCHOOL**

A study of language and literature in the elementary school including contributions of allied disciplines such as semantics and linguistics. Focus is on the processes of communication and application to elementary school curriculum. Introduction to bibliotherapy. Prerequisite: Education 610, Teaching Elementary School Language Arts. 4 credits.

## **807. SURVEY OF READING**

An investigation of the research in reading and reading instruction. Emphasis is on the individual learner, the reading process, and the process of learning to read. Comparison of current diagnostic, developmental, and evaluative methods and materials. Prerequisite: Education 614, Teaching Elementary School Reading. 4 credits.

## **808. DIAGNOSIS AND REMEDIAL READING IN THE ELEMENTARY SCHOOL**

Investigations of the nature and causes of reading disability. Study of diagnostic and remedial procedures and materials

through case studies, discussions, demonstrations, and practice. Prerequisite: Education 785 and 807. 4 credits.

## **809. PRACTICUM IN DEVELOPMENTAL AND REMEDIAL READING AND LANGUAGE AT THE ELEMENTARY LEVEL**

Individual and small-group work with children will provide opportunities for clinical analysis, micro-teaching, and evaluation. Seminars will focus on the processes of reading and language and the effects of a variety of methods and materials on learning. Prerequisite: Education 808 (may be taken concurrently) and permission of instructor at least one month before beginning the course. 4 credits.

## **810. READING AND STUDY 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. Prerequisite: secondary school teaching experience. 4 credits.

## **811. DIAGNOSTIC AND REMEDIAL READING IN THE SECONDARY SCHOOL**

Study of techniques for diagnosing the reading problems of secondary school students and developing appropriate remedial procedures. Emphasis will be given to reading problems encountered in the various content areas of the secondary school curriculum. Prerequisite: Education 807 or 810. 4 credits.

## **812. PRACTICUM IN DEVELOPMENTAL AND REMEDIAL READING AND LANGUAGE AT THE SECONDARY SCHOOL LEVEL**

Supervised tutoring of secondary school students in order to develop techniques for improving reading skills. Seminars will focus upon corrective techniques and the integration of reading skills to the content areas. Prerequisite: Education 811 (may be taken concurrently) and permission of instructor at least one month before beginning of the course. 4 credits.

## **813. FIELD PRACTICUM IN READING**

This phase of the program is designed to expand the student's competence in areas where the greatest need is felt. This is a highly individualized portion of the program where the student plans activities which are most useful to him. 4 credits.

## **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 credits.

## Education

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### **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 credits.

### **821. PSYCHOLOGY OF VOCATIONAL DEVELOPMENT**

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

### **822. PSYCHOLOGICAL TESTS IN PERSONNEL SERVICES**

An analysis of evaluative instruments and techniques which have particular utility in personnel services. Comparisons of sample instruments in terms of psychological or factorial meanings and predictive uses. 4 credits.

### **823. GROUP COUNSELING**

An analysis of group dynamics as they apply in group situations relevant to personnel services. Prerequisite: Education 820. 4 credits.

### **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 credits.

### **825. LABORATORY IN COUNSELING**

Supervised application of counseling through involvement in simulated counseling situations in a laboratory setting. Prerequisite: Education 820. 4 credits.

### **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 credits.

### **827. ORGANIZATION AND ADMINISTRATION OF PERSONNEL SERVICES**

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

### **828. ADVANCED COUNSELING THEORY AND PRACTICE**

A detailed analysis of the counseling relationship: its characteristics, processes, and outcomes. Prerequisite: permission of instructor. 4 credits.

### **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: Education 828 and permission of instructor. 4 credits.

### **830. RESEARCH IN PERSONNEL SERVICES**

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

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

Supervised Practicum: An exploratory summer practicum in a local summer elementary school designed to examine teaching as a career and to prepare for the internship in the fall. The 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 Pre-service Teachers. 8 credits.

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

Supervised Practicum: An exploratory summer practicum in a local summer high school designed to examine teaching as a career and to prepare for the internship in the fall. The 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 credits.

### **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 are the following: (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 credits.

### **841. CHILD DEVELOPMENT FOR THE EARLY CHILDHOOD PROFESSIONAL**

As a means of understanding child growth components the course will involve students in extended contacts with significant adults related to children in an early learning environment. Such involvement includes home visits to interview parents, relatives, and to observe the child in the family setting. These primary experiences will be extended through readings, discussions, case study models, film viewings, and continued in-depth child study. Prerequisite: previous experience with young children. 4 credits.

### **843. ENVIRONMENT FOR EARLY CHILDHOOD**

An examination of a variety of Early Childhood environments with attention to use of time, space, and materials. The course is designed to assist Early Childhood professionals to examine their multiple roles in providing appropriate Learning Center adjustments in order to maximize the personal development of different children. Prerequisite: previous experience with young children. 4 credits.

### **846. ASSESSMENT IN EARLY CHILDHOOD**

The course will necessitate that students be familiar with, administer, as well as design, a range of assessment materials for young children. Within the context of Early Learning Centers students will employ various strategies for the selection and utilization of clusters of assessment materials. An essential phase of the course involves the collection and organization of data concerning the children assessed. Prerequisite: Education 841 and 843. 4 credits.

### **848. CONTEMPORARY INFLUENCES UPON EARLY CHILDHOOD EDUCATION**

A survey of contemporary influences upon Early Childhood Education involving an examination of a variety of early childhood models in this country and abroad largely through field experiences (United States, Canada, and England). The course is designed with a view to the student's individual application to his specific early learning situation. Prerequisite: current involvement with a specific group of children. 4 credits.

### **850. FOUNDATIONS OF EARLY CHILDHOOD EDUCATION**

An examination of the historical roots that underlie many contemporary practices in Early Childhood Education. The course seeks to provide the professional with a perspective of historical precedents in content, methodology, and change along with extended study and review in child development, assessment, classroom environments, and contemporary practices in order to function more effectively in current work with young children. Prerequisite: Education 841, 843, 846, and 848. 4 credits.

### **853. SEMINAR IN CURRICULUM STUDY**

The techniques and procedures of curriculum development and strategies for curriculum change in the public schools. Prerequisite: teaching experience. 4 credits.

### **858. ANALYSIS OF TEACHING**

A 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 credits.

### **861. PUBLIC SCHOOL ADMINISTRATION**

An introductory course examining major issues in policy-making, school management, personnel, public relations, finance, and research in school administration. Prerequisite: teaching experience. 4 credits.

### **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: Education 861. 4 credits.

### **863. SEMINAR IN EDUCATIONAL ADMINISTRATION**

Cases and concepts in educational administration. Prerequisite: Education 861. 4 credits.

### **864. PERSONNEL AND COMMUNICATION IN EDUCATIONAL ORGANIZATIONS**

Problems arising from the communication process will be examined and attention given to implications of group problem-solving processes. Interpersonal relations and group dynamics among students, faculty, staff, administration, and the community will be given attention. Classes will meet once weekly. Emphasis will be upon application of theories. 4 credits.

# Electrical Engineering

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## 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 credits.

## 867. LEGAL ASPECTS OF SCHOOL ADMINISTRATION

Emphasis is on federal and state laws which establish the duties, privileges, and responsibilities of school board members, superintendents, and teachers. The legal aspects of school district organization, negotiation procedures and personnel policies, fiscal operations, school building construction, compulsory attendance, pupil transportation services, and the current legal issues involved in state and federal aid to education. Prerequisite: Education 861 and 863. 4 credits.

## 869. PRACTICUM IN EDUCATIONAL ADMINISTRATION

Supervised practical experience in dealing with problems in educational administration. Prerequisite: Education 863. 4 credits.

## 881. METHODS AND TECHNIQUES OF EDUCATIONAL RESEARCH

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

## 883. ADVANCED PSYCHOLOGY OF HUMAN LEARNING

Special topics in the field of educational psychology with emphasis on the learning process: (a) examination of learning situations in the classroom in the light of experimental research; (b) examination and evaluation of learning situations in the light of the major theories of learning. Prerequisite: Education 657, Psychology of Human Learning. 4 credits.

## 884. ADVANCED HUMAN DEVELOPMENT

A personal exploration of the social, psychological, and educational aspects of human development. Special emphasis on emotional growth through school practices in human encounter. Prerequisite: permission of instructor. 4 credits.

## 886. PHILOSOPHY OF EDUCATION

A comparative analysis of contemporary educational objectives and practices and the philosophical foundations upon which they are based. 4 credits.

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

The two cultures are treated as a unit; culture change is discussed. Issues of current interest are explored, e.g., poverty, school desegregation, the schooling of geographically mobile children, problems of social mobility and abundance, the rise of the counseling and healing trades, and teachers' quest for professionalism. The education of "culturally deprived" and "culturally endowed" children receives special attention. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. 4 credits.

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

This course deals with ethnic stratification and inter-group processes both inside and outside the school. The public schooling of disadvantaged groups such as black, Indian, white Appalachian, and Mexican Americans receives special attention. Caste and class relations between schoolmen, parents, and pupils are examined within social contexts as slums, reservations, Levittowns, and "golden ghettos." A socio-anthropological perspective is emphasized. 4 credits.

## 895. INDEPENDENT STUDY IN EDUCATION

An 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 credits.

## 899. THESIS

Prerequisite: permission of the department. 4-8 credits.

# Electrical Engineering (50)

**Chairman:** Joseph B. Murdoch

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

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

**ASSISTANT PROFESSOR:** K. Sivaprasad

**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 701 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.

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 71.

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.

### Bioelectronic and Medical Systems

Topics of study in this area include biotelemetry of physiological data from humans, animals, and plants, and applications of signal processing and instrumentation techniques to medical areas.

### Communications Systems and Information Theory

Areas of interest and activity include electromagnetic and acoustical 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; 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 probing of media with pulses, propagation studies in weakly turbulent media such as sea, the atmosphere, and plasmas. Acoustic reverberation studies in the ocean.

### Network Theory

Active network synthesis techniques, application of network theory to transportation systems, sensitivity studies of passive and active network synthesis methods, digital adaptive equalizers with particular attention paid to the problems caused by fabrication techniques, 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.

# Electrical Engineering

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## **Solid State Electronics; Semiconductor Devices and Materials**

Experimental and theoretical considerations of semiconductor devices and materials including device fabrication technology, e.g., laboratory work involving silicon monolithic devices, research in photosensors, especially in the infrared, and in infrared systems with applications to the remote sensing of the environment.

## **620. ELECTRONICS AND INSTRUMENTATION**

A service course for those students not in engineering or physics. No attempt is made to cover the topics in mathematical or engineering detail. Emphasis is placed on making the student aware of problems which he is likely to encounter when using electronic equipment. Proper technique for using electronic instruments is pointed out in classroom demonstrations and laboratory experiments. Topics covered include D.C. and A.C. circuits, electronic amplifiers, grounding and shielding problems, transducers, electronic instruments, schematic reading, transients, noise problems, and digital techniques. 3 recitations; 1 laboratory; 4 credits.

## **701. APPLIED ELECTROMAGNETIC FIELDS**

Introduction to Maxwell's equations; boundary value problems in electrostatics and magnetostatics; plane wave propagation; reflection and refraction in isotropic media; guided wave propagation; rectangular and cylindrical wave guides; simple resonators; elements of microwave circuits, linear antennas; aperture antennas, arrays of dipoles; directivity of receiving antennas and reciprocity. Prerequisite: Electrical Engineering 509, Electromagnetic Fields, or equivalent. 3 recitations; 1 laboratory; 4 credits.

## **706. ADVANCED NETWORK THEORY**

Matrices, linear graph theory and the topological analysis of active and passive networks; concepts of natural frequencies and state; formulation and solution of state equations; application of linear graph and state techniques to real-world system problems. Prerequisite: Electrical Engineering 503, Electrical Circuit Theory. 4 credits.

## **711. DIGITAL SYSTEMS**

An extension of Electrical Engineering 543 to more advanced switching theory techniques (i.e., design of unclocked sequential circuits, minimization of multiple output circuits, etc.) and digital design tools (i.e., L.S.I., multiplexing, etc.). A variety of applications will be studied. Prerequisite: Electrical Engineering 543 or permission of instructor. 3 recitations; 1 laboratory; 4 credits.

## **712. LOGICAL DESIGN OF DIGITAL COMPUTERS**

Computer architectures, including arithmetic, memory, control, and input-output units, are studied with emphasis on the trade-offs between hardware, software, and cost. In the laboratory, students will be provided with "hands on" experience with machine language programming, interfacing of peripherals, etc., on several mini-computers and micro-computers. Prerequisite: Electrical Engineering 543 or permission of instructor. 3 recitations; 1 laboratory; 4 credits.

## **714. MINICOMPUTER APPLICATIONS ENGINEERING**

Principles of organization and operation of mini-computer based systems. Topics include interfacing of special purpose peripherals, data structures, control structures, program and data organization, microprogramming, and real time monitor systems. Applications include communication, automated measurement, and process control systems. Prerequisites: Electrical Engineering 543 and programming experience, or permission of instructor. 3 recitations; 1 laboratory; 4 credits.

## **727. POWER SYSTEMS**

An introduction to the modeling and planning of electric power transmission systems. Prerequisite: Electrical Engineering 503, Electrical Circuit Theory. 4 credits.

## **741. FUNDAMENTALS OF ACOUSTICS**

The development of the acoustic wave equation for air; laws of reflection, refraction, and absorption; characteristics of acoustic sources; measurement of acoustic sources; microphones; measurement of sound level; properties of acoustic materials, ultra-sonics, architectural acoustics. Prerequisite: Physics 408, General Physics II; Mathematics 527, Differential Equations. 3 recitations; 1 laboratory; 4 credits.

## **757. FUNDAMENTALS OF COMMUNICATIONS**

Introduction to communications systems, Fourier analysis of signals, amplitude and frequency modulation, detection, digital and sampled data signals, noise in electrical circuits. 3 recitations; 1 laboratory; 4 credits.

## **758. COMMUNICATION SYSTEMS**

Fundamentals of the design of high frequency communication systems. RF amplification, modulators for amplitude and frequency modulation systems, receiving techniques, antennas, free space propagation, propagation characteristics of the ionosphere. Prerequisite: Electrical Engineering 509, Electromagnetic Fields; Electrical Engineering 757; or equivalent. 3 recitations; 1 laboratory; 4 credits.

## 762. ILLUMINATION

Radiation; color and spectra; physics of light to production; sources of ultraviolet, visible, and infrared energy; lamp circuitry; control of light; illumination design. The course will be conducted on a seminar basis with each student researching and discussing the above topics and doing a project in the application of visible or near-visible energy in business and industry, education, the ocean, agriculture, medicine, or other areas. 2 or 4 credits.

## 770. INTEGRATED CIRCUIT DESIGN AND TECHNOLOGY

An introduction to the principles of operation, design, processing, and technology of linear and nonlinear integrated circuits. Bipolar and unipolar structures, including surface-controlled devices, will be considered. Related topics will include thin-film hybrid circuit techniques, vacuum technology, opto-electronic devices, and microwave active circuits. Prerequisites: Electrical Engineering 605, Electronic Properties of Materials and Devices, and 510, Linear Electronic Circuits. 2 recitations; 2 laboratories; 4 credits.

## 775. APPLICATIONS OF INTEGRATED CIRCUITS

The design and construction of linear and nonlinear electronic circuits using existing integrated circuits with an extreme emphasis on the use of operational amplifiers. This course is primarily a laboratory course for those who are interested in the practical applications of nondigital integrated circuit devices. 4 credits.

## 781. OCEAN INSTRUMENTATION PROJECT

An interdisciplinary effort to define and solve a real-world problem involving measurements of physical, chemical, or biological parameters in an ocean or fresh water environment. Students will operate as a team to formulate system specifications, assemble components, and design a test procedure for demonstrating the feasibility of the prototype system. The project will culminate in the preparation of a written final report and oral demonstration before a panel of invited experts in the field. Prerequisite: senior standing in Engineering. Bi-weekly conferences and individually scheduled laboratory sessions. 4 credits.

## 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. 3 recitations; 1 laboratory; 4 credits.

## 784. BIOELECTRONICS

A study of topics in bioelectronics including biotelemetry, physiological transducers, and modeling. Animal systems such as the nervous system, circulatory system, the ear, and the eye will be studied from an engineering point of view. Prerequisite: Electrical Engineering 510, Linear Electronic Circuits, or equivalent. 4 credits.

## 785. UNDERWATER ACOUSTICS

An introduction to the field of underwater acoustics including vibrations, propagation, reflection, scattering, reverberation, attenuation, sonar equations, ray and mode theory, radiation of sound, transducers, and small and large signal considerations. Prerequisite: senior or graduate status, and permission of instructor. 4 credits.

## 786. INTRODUCTION TO RADIO ASTRONOMY

Characteristics of 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, galactic background. Line emissions (hydrogen, hydroxyl), quasars, pulsars, techniques of observation and data reduction, radiometry, polarimeters, correlation interferometers, aperture synthesis. Prerequisite: senior or graduate status within College of Technology. 4 credits.

## 796. SPECIAL TOPICS IN ELECTRICAL ENGINEERING

New or specialized courses are presented under this listing, on sufficient demand. Independent study can be given under this course title. Prerequisite: permission of instructor. 2 or 4 credits.

## 801. ELECTROMAGNETIC FIELD THEORY

Review of Maxwell's equations. Green's function method for solution of electrostatic problems. Wave propagation in isotropic, anisotropic, and ionized media; propagation over a plane; surface waves. Prerequisite: Electrical Engineering 701. 3 credits.

## 802. ELECTROMAGNETIC WAVE THEORY

Diffraction and scattering; scattering from objects with edges and without edges; introduction to wave propagation in random and turbulent media. Prerequisite: Electrical Engineering 801. 3 credits.

# Electrical Engineering

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## 803. MICROWAVE SYSTEMS

Waveguide propagation—rectangular, cylindrical, and strip-line; microwave generation devices; impedance measurements; and signal collection detection. Propagation of microwaves at centimeter and millimeter wavelengths. Prerequisite: Electrical Engineering 801. 3 credits.

## 804. ANTENNAS

Radiation of electromagnetic waves, current distribution on extended structures, antenna impedance considerations. Aperture antennas, parabolic reflectors, horns, lenses. Multi-element arrays, surface wave devices, aperture synthesis, phase arrays. Prerequisite: Electrical Engineering 801. 3 credits.

## 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 credits.

## 812. FILTER DESIGN AND SYNTHESIS

Approximation theory; driving point and transfer synthesis techniques; passive, active, and digital filters. Prerequisite: Electrical Engineering 811. 3 credits.

## 813. NONLINEAR NETWORKS

Introduction to basic nonlinear phenomena and methods, time varying and nonlinear passive and active networks, free and forced responses, jump phenomena, sub-harmonic generation, frequency domain stability criteria. Prerequisite: Electrical Engineering 811. 3 credits.

## 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 credits.

## 817. NETWORK ANALYSIS

Topological properties and analysis of networks; one to n-port networks; natural frequencies; eigen values and state variables; parts of network functions, Fourier and Hilbert transforms; the approximation problem in the time- and frequency-domains. Prerequisite: Electrical Engineering 811. 3 credits.

## 831. SOLID STATE ELECTRONICS I

A study of topics in solid state electronics including semiconductor physics, crystal structure, band theory, transport pheno-

menon, recombination, and PN junctions. Semiconductor fabrication process theory will be introduced. Prerequisite: Electrical Engineering 505, Electronic Properties of Materials and Devices, or equivalent. 3 credits.

## 832. SOLID STATE ELECTRONICS II

A continuation of Electrical Engineering 831, emphasizing the theory of semi-conductor devices including bipolar, field-effect, and surface-controlled transistors, monolithic and hybrid integrated circuits, photoconductors, injection luminescent diodes, semiconductor laser and bulk effect devices, as well as selected applications and topics in theory of semiconductor technology. Prerequisite: Electrical Engineering 831. 3 credits.

## 833. SOLID STATE ELECTRONICS III

A study of advanced topics in solid-state electronics either not covered in Electrical Engineering 831 and 832 or with coverage in considerable depth requiring extensive use of published literature and library resources. This course will allow and require independent study of selected topics of current interest in solid-state electronics. Prerequisite: Electrical Engineering 832. 3 credits.

## 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. Prerequisite: Electrical Engineering 811. 3 credits.

## 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: Electrical Engineering 839. 3 credits.

## 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: Electrical Engineering 782. 3 credits.



## 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: Electrical Engineering 851. 3 credits.

## 856. SWITCHING THEORY

Combinational circuits—including functional decomposition, non-binary logic, and cellular networks. Sequential networks—including analysis, transient behavior, state reduction methods, state assignment, and synthesis. Prerequisite: Electrical Engineering 711. 3 credits.

## 891-892. RESEARCH

3 credits 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 credits per semester.

## 899. MASTER'S THESIS

6 credits.

## Engineering Ph.D. Program (54)

**Committee Chairman:** Victor D. Azzi

**PROFESSORS:** Victor D. Azzi, Fletcher A. Blanchard, Robert W. Corell, Albert D. Frost, Shan S. Kuo, Joseph B. Murdoch, Godfrey H. Savage, Charles K. Taft, Alden L. Winn, Asim Yildiz

**ASSOCIATE PROFESSORS:** Ronald R. Clark, Stephen S.T. Fan, Glen C. Gerhard, Filson H. Glanz, Louis H. Klotz, Harold E. Langley, Donald W. Melvin, William Mosberg, John P. Nielsen, John L. Pokoski, Kerwin C. Stotz, Russell L. Valentine, Tung-Ming Wang, John A. Wilson

**ASSISTANT PROFESSORS:** Barbaros Celikkol, David E. Limbert, Kondagunta Sivaprasad, Steven Slater, Robert S. Torrest, Gail D. Ulrich

**ENGINEERING Ph.D. COMMITTEE:** Victor D. Azzi, 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, Chairman

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 projects. The second 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, fluidic systems, nonlinear decoupling control, pulse data control, societal systems, facility systems, and social and management systems.

#### Signal Processing: Ronald R. Clark, Chairman

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, biology, instrumentation, and control.

Current research topics include: network synthesis, bioelectronic telemetry, radio astronomy, ionospheric irregularities, pattern recognition, semi-conductor device fabrication, coherent signal analysis, surface-wave antennas, digital control, nonlinear interacting system-control, and fluidics.

## Engineering Ph.D. Program

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### **Theoretical and Applied Mechanics:** Victor D. Azzi, Chairman

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, 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, and dislocation theories.

### **Transport Phenomena:** Stephen S.T. Fan, Chairman

This area deals with the subjects of fluid mechanics; conductive, convective, and radiative heat transfer; and diffusive mass transfer in a generalized and coordinated approach. In addition to their fundamental role in traditional engineering activities, transport-phenomena studies are expected to make significant engineering contributions in the areas of environmental control, oceanography, space exploration, and biomedical engineering.

Current research activities include pollution control, biomedical engineering, combustion, adsorption, simultaneous heat and mass transfer, heat transfer with phase change, liquid pumping cavitation, polymer processing, vortex flow, and flow through porous media.

## 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 has sufficient background in the area in which he 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 chairman of the student's area. This committee will assist the student in outlining his program and in preparing him for his qualifying examination and may require him 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 chairman 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 and/or a demonstrated facility in a special research technique such as digital or analog computation. The student, depending on his educational objectives, may also be required by his 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.

### **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 chairman to determine the particular course work and research activity that may be applicable to his 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 (62)

**Chairman:** Robert Hapgood

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

**ASSOCIATE PROFESSORS:** Thomas A. Carnicelli, Michael DePorte, Karl Diller, Carl Dawson, Lewis C. Goffe, Terence P. Logan, Mark R. Smith, Theodore Weesner, John A. Yount

**ASSISTANT PROFESSORS:** Earl Briden, S. Anthony Caldwell, Elizabeth H. Hageman, Hugh M. Potter III, Robert M. Rehder, Alan H. Rose, Susan M. Schibanoff, David V. Siddall, Charles Simic

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 Examinations scores for the Aptitude Test and the Advance 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

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.

**Courses:** An M.A. candidate must pass eight four-credit courses. Six courses, including at least two 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 within 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.

**Language:** An M.A. candidate must pass a reading examination in one of the following languages: French, German, Greek, Italian, Latin, Russian, Spanish.

**Paper:** Each candidate for the M.A. degree must register for four credits of English 895 or 896 and produce a substantial scholarly paper. The department occasionally accepts a body of creative writing (a novel, a collection of short stories, poems, essays) in

lieu of the scholarly paper. (The above requirements do not necessarily apply to the specialized options listed below.)

### Specialized Option 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 in local two-year colleges are features of the program. Fellowships supported by a federal grant under the Education Professions Development Act, may be available (subject to availability of funding). Further details are available in the brochure describing the program and from the program's director.

### Specialized Option 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 fast, detailed criticism of each student's writing by instructors and fellow students. Each student takes at least two workshops in his or her specialty, and may elect to take an additional workshop in another area as well. Form-and-theory courses and literature courses complete the program.

Upon completion of the required courses the student submits a portfolio of writing to the staff. The portfolio might consist of short stories, a novel, 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.

### 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 study and 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 of study primary stress is upon courses, while in the second 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), and 2) written qualifying examinations in five areas of English and American literature and language. A student must also write a dissertation and defend it at a final oral examination. The program is designed to be completed within three years of full-time study after the M.A.

Graduate students should note that not all seminars are offered every year.

M.A. and Ph.D. students holding assistantships teach under supervision; such teaching is considered a vital part of the student's professional training.

A more complete guide to the Department's graduate program is available from the chairman of the Graduate Committee, Associate Professor Karl C. Diller.

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

Workshop discussion of advanced writing problems and readings of students' fiction. Individual conferences. Prerequisite: English 625-626 (Writing Fiction) or its equivalent. Written permission of instructor required for registration. May be repeated for credit with approval of department chairman. 4 credits.

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

A workshop course for advanced students of writing. The course provides a second year of training for those interested in journalism, but it also provides an opportunity for students to practice other forms of non-fiction writing. Individual conferences. May be repeated for credit with the approval of the department chairman. Written permission of instructor required for registration. 4 credits.

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

Workshop discussions of advanced writing problems and readings of students' own poetry. Individual conferences. Prerequisite: English 626-628 or its equivalent. Written permission of

instructor required for registration. May be repeated for credit with the approval of the department chairman. 4 credits.

### 707. FORM AND THEORY OF FICTION

An introduction to the form and theory of fiction from the writer's point of view. 4 credits.

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

An introduction to the form and theory of non-fiction from the writer's point of view. 4 credits.

### 709. THE FORM AND THEORY OF POETRY

An introduction to the form and theory of poetry from the poet's point of view. 4 credits.

### 710. CRITICAL ANALYSIS OF FICTION

A course designed to acquaint the student with a variety of modern approaches to the criticism of fiction, with special emphasis upon developing skills in close analysis of individual works. 4 credits.

### 711. CRITICAL ANALYSIS OF POETRY AND DRAMA

A nonhistorical, non-genre approach to individual poems and plays with emphasis on the works themselves. 4 credits.

### 712. CRITICAL ANALYSIS OF EXPOSITION

A course designed especially for the English Teaching major in which students analyze essays and write non-fiction prose. The course will stress a variety of critical approaches and introduce several methods of teaching composition. 4 credits.

### 713, 714/813, 814. LITERARY CRITICISM

Major critics from Plato to the present and the chief critical approaches to literature. 4 credits.

### 715/815. APPLIED LINGUISTICS

Methods of teaching and learning foreign languages, with background work on theories of language acquisition. The emphasis is on the methodology of teaching English as a second language, but students interested in teaching other languages may do projects on those languages. 4 credits.

### 716/816. PROBLEMS IN APPLIED LINGUISTICS

A consideration of such problems as language acquisition in children and adults, bilingualism, and linguistic field methods. 4 credits.

### 718/818. ENGLISH LINGUISTICS

A descriptive approach to modern English grammar, emphasizing the insights provided by linguistic analysis. 4 credits.

**719. ENGLISH GRAMMAR**

A review of English grammar including both traditional and contemporary approaches. 4 credits.

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

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

**743/843. AMERICAN TRANSCENDENTALISTS**

Emerson, Thoreau, and other transcendentalists. 4 credits.

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

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

**745/845. AMERICAN POETRY OF THE NINETEENTH CENTURY**

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

**746/846. AMERICAN REALISM AND NATURALISM**

Twain, Henry James, Adams, Stephen Crane, Dreiser, and others. 4 credits.

**747, 748/847, 848. AMERICAN FICTION AND DRAMA OF THE TWENTIETH CENTURY**

Fitzgerald, Hemingway, O'Neill, Faulkner, and others. 4 credits.

**749/849. AMERICAN POETRY OF THE TWENTIETH CENTURY**

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

**752/852. HISTORY OF THE ENGLISH LANGUAGE**

A study of the evolution of the English language, with special emphasis upon the relation between linguistic change and literary style. 4 credits.

**753/853. OLD ENGLISH**

An introduction to Old English language and literature through readings of selected poetry and prose. 4 credits.

**754./854. BEOWULF**

A reading of the poem and an introduction to the scholarship. Prerequisite: English 753. 4 credits.

**755, 756/855, 856. CHAUCER**

755/855: Chaucer's allegorical poems and *Troilus and Criseyde*. 756/856: *The Canterbury Tales*. 4 credits.

**757, 758/857, 858. SHAKESPEARE**

The major plays of Shakespeare. 757/857 surveys a number of representative plays; 758/858 studies a few plays more intensively. 757 (857) is prerequisite to 758 (858). 4 credits.

**759/859. MILTON**

Milton's life and times, all his poetry, and a selection of his prose. 4 credits.

**763, 764/863, 864. ENGLISH LITERATURE IN THE SIXTEENTH CENTURY**

763/863: Major literary figures of the Continental Renaissance (in translation), including Petrarch, Machiavelli, Ariosto, Rabelais, Montaigne, Cervantes, and Erasmus; major English writers of the period, including More, Skelton, Wyatt, and Surrey. 764/864: A study of Sidney, Spenser, and other non-dramatic poets and prose writers of the Elizabethan period. 4 credits.

**765, 766/865, 866. ENGLISH LITERATURE IN THE SEVENTEENTH CENTURY**

765/865: Major writers of prose and poetry in the first half of the century; special emphasis upon the relationships between the metaphysical and the classical modes of poetry. 766/866: Restoration comedy of manners, heroic drama, verse, satire; Dryden, Milton, and Bunyan. 4 credits.

**767, 768/867, 868. ENGLISH LITERATURE IN THE EIGHTEENTH CENTURY**

767/867: Swift, Pope, Addison, Gay, Defoe. 768/868: Fielding, Gray, Johnson, Boswell, Gibbon, Goldsmith, Sterne, Blake. 4 credits.

**769, 770/869, 870. THE ENGLISH ROMANTIC PERIOD**

769/869: Wordsworth, Coleridge, Lamb, Hazlitt, DeQuincey. 770/870: Byron, Shelley, Keats. 4 credits.

**771, 772/871, 872. VICTORIAN PROSE AND POETRY**

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

**773, 774/873, 874. BRITISH LITERATURE OF THE TWENTIETH CENTURY**

773/873: Survey of the novels of the period. 774/874: Survey of the poetry of the period. 4 credits.

**781, 782/881, 882. INTRODUCTION TO ENGLISH DRAMA**

The development of English drama, exclusive of Shakespeare,

# English

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from the Middle Ages to the present, 781: From the Middle Ages to the closing of the theatres in 1642. 782: From the Restoration to the present. 4 credits.

## **783/883. THE ENGLISH NOVEL OF THE EIGHTEENTH CENTURY**

The rise and development of the novel through study of selected major works by Defoe, Richardson, Fielding, Smollett, Sterne, and Austen. 4 credits.

## **784/884. THE ENGLISH NOVEL OF THE NINETEENTH CENTURY**

Representative novels from among the following authors: Austen, Scott, Dickens, Thackeray, Emily Bronte, Charlotte Bronte, Trollope, George Eliot, Hardy, and Conrad. 4 credits.

## **791, 792. (ENGLISH EDUCATION) PROBLEMS IN THE TEACHING OF HIGH SCHOOL ENGLISH**

Principles and methods of teaching literature, composition, and language in secondary schools. Prerequisite: a grade of C or better in Education 658, Principles of Teaching. 2 credits.

## **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 credits.

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

The precise topics and methods of each section will vary.

- |                                |                          |
|--------------------------------|--------------------------|
| 1. Old English Literature      | 8. The Twentieth Century |
| 2. Medieval Literature         | 9. The Drama             |
| 3. The Renaissance             | 10. The Novel            |
| 4. The Seventeenth Century     | 11. Poetry               |
| 5. The Eighteenth Century      | 12. Non-fiction          |
| 6. The English Romantic Period | 13. American Literature  |
| 7. The Victorian Period        | 14. A Literary Problem   |

Graduate faculty. 4 credits.

## **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. Required of EPDA fellows and open to other graduate students with permission of instructor. 4 credits.

## **820. SEMINAR IN LINGUISTICS**

4 credits.

## **821. SEMINAR—STUDIES IN OLD ENGLISH**

4 credits.

## **824. SEMINAR—STUDIES IN MEDIEVAL LITERATURE**

4 credits.

## **825. SEMINAR—STUDIES IN SIXTEENTH CENTURY LITERATURE**

4 credits.

## **827. SEMINAR—STUDIES IN SHAKESPEARE**

4 credits.

## **828. SEMINAR—STUDIES IN MILTON**

4 credits.

## **829. SEMINAR—STUDIES IN EARLY SEVENTEENTH CENTURY LITERATURE**

4 credits.

## **830. SEMINAR—STUDIES IN EIGHTEENTH CENTURY LITERATURE**

4 credits.

## **832. SEMINAR—STUDIES IN THE ROMANTIC PERIOD**

4 credits.

## **833. SEMINAR—STUDIES IN THE VICTORIAN PERIOD**

4 credits.

## **834. SEMINAR—STUDIES IN TWENTIETH CENTURY BRITISH LITERATURE**

4 credits.

## **837. SEMINAR—STUDIES IN AMERICAN LITERATURE OF THE NINETEENTH CENTURY**

4 credits.

## **838. SEMINAR—STUDIES IN TWENTIETH CENTURY AMERICAN LITERATURE**

4 credits.

## **840. SEMINAR—STUDIES IN ENGLISH DRAMA**

4 credits.

## **895, 896. READING AND RESEARCH**

Graduate Faculty. 4 or 8 credits.

## **899. MASTER'S THESIS**

6 credits.

## **999. DOCTORAL RESEARCH**

## Entomology (20)

**Chairman:** 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. 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

Insects and arachnids in relation to public health. The more important disease carriers, their biologies, and means of control. Adapted especially for students who are interested in public health or medicine. Elective for juniors and seniors. Mr. Blickle. 2 lectures; 1 laboratory; 4 credits.

### 707, 708. ADVANCED ENTOMOLOGY

Insect anatomy, insect ecology, and systematic entomology. Required of entomology majors. Open to others by permission of instructor. R 1. Taxonomy; R 2. Morphology; R 3. Aquatic Insects; R 4. Insect Physiology. Mr. Blickle and staff. 2 lectures; 1 4-hour laboratory; 4 credits.

### 709, 710. ADVANCED ECONOMIC ENTOMOLOGY

Studies in the specialized phases of entomology. This course is structured to meet the objectives of the individual student. R 1. Agricultural Entomology; R 2. Biological Control of Insects; R 3. Chemical Control of Insects; R 4. Regulatory Entomology; R 5. Structural Pest Control. Mr. Fisher and staff. Required of entomology majors. Open to others by permission of instructor. Hours to be arranged. 2 or 4 credits.

### 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 credits.

## French (63)

**Chairman:** Grover E. Marshall

**PROFESSOR:** Louis J. Hudon

**ASSOCIATE PROFESSORS:** Edna S. Hudon, Jack R. Vrooman

**ASSISTANT PROFESSORS:** Rose Antosiewicz, Lydia Crowson, Robert Davis, 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 11. 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. This program is suspended until there is again sufficient interest in it. Those interested in the program are urged to express that interest to the dean of the Graduate School and to the department. The program consists of eight courses and a master's thesis.

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

An interdepartmental course. A critical study of the objectives, methods, and techniques used in teaching Spanish,

## Genetics

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French, German, and Latin at all levels from elementary through college. Discussion, demonstration, preparation of instructional materials, micro-teaching of the language skills. Prerequisite: permission of the instructor. No credit toward a French major. (Also offered as German 791, Latin 791, and Spanish 791.) 4 credits.

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

Readings in the epic, lyric poetry, and the romance. 3 credits. (Not offered in 1974-75.)

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

Readings in the literature of the sixteenth century. 3 credits. (Not offered in 1974-75.)

### 859-860. FRENCH LITERATURE OF THE SEVENTEENTH CENTURY

Readings in the literature of the seventeenth century. 3 credits. (Alternate years; not offered in 1974-75.)

### 861-862. EIGHTEENTH CENTURY FRENCH LITERATURE AND THOUGHT

Readings in the Age of Enlightenment. 3 credits. (Alternate year; offered in 1974-75.)

### 867-868. NINETEENTH CENTURY FRENCH LITERATURE

Readings in Romantic, Parnassian, and Realistic literature of the century. 3 credits. (Alternate years; not offered in 1974-75.)

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

Studies in French poetry from Baudelaire to the present. 3 credits. (Alternate years; not offered in 1974-75.)

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

Readings in the French novel and theater of the twentieth century. 3 credits. (Alternate years; offered in 1974-75.)

### 888. A SEMINAR IN FRENCH LITERATURE

A study of French authors chosen by the instructor. 3 credits. (Not offered in 1974-75.)

### 890. ADVANCED LANGUAGE AND STYLE

Translation of literary texts, intensive study of the principal techniques of style, *explication de textes*. 3 credits.

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

Individual guided study in special topics. Prerequisite: permission of department chairman. Variable 1-4 credits.

### 899. MASTER'S THESIS

1-6 credits.

## Italian (64)

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

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

## Genetics Program (97)

**Chairman:** Gerald M. Dunn

**PROFESSORS:** 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:** James P. Barrett, Thomas P. Fairchild, Frank K. Hoornbeek, J. Brent Loy, Willard E. Urban, Jr.

**ASSISTANT PROFESSORS:** Yun Tzu Kiang, 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 chairman of the department in which he 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 the departments of Animal Sciences, Biochemistry, Institute of Natural and Environmental Resources, Microbiology, Plant Science, and Zoology as well as faculty from the Agricultural Experiment Station and the U.S. Forest Service, Northeastern Forest Experiment Station. Areas of specialization in the program are: genetics of plants, animals, microorganisms, and viruses, with emphasis in physiological and quantitative genetics.



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 genetic 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 his 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 chairman of the Genetics Program, with the concurrence of the chairman 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 his guidance committee, and will include the courses in the core curriculum. Students must complete a dissertation on original research in genetics.

A student must satisfy a foreign language requirement by demonstrating proficiency in one language through successful completion of a Graduate School Foreign Language Test administered by Educational Testing Service.

### 705. POPULATION GENETICS

Population growth and regulation; the distribution of genes in populations; factors affecting gene frequency such as mode of inheritance, mating systems, mutation, migration, genetic drift, selection, and linkage disequilibrium; genetic load, cost of natural selection, and ecological genetics. Mr. Kiang. Prerequisite: Zoology 604, Principles of Genetics; and Forest Resources 528, Applied Statistics I; or equivalents, or permission of instructor. 4 lectures; 4 credits.

### 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: Zoology 604, Principles of Genetics, or equivalent, and permission of instructor. 2 credits.

### 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: Zoology 604, Principles of Genetics, or equivalent, or permission of instructor. 4 lectures; 4 credits. (Alternate years; offered 1975-76.)

### 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: Biochemistry 751 or permission of instructor. 3 lectures; 1 laboratory; 4 credits. (Alternate years, offered 1975-76.)

### 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: Forest Resources 711; and Mathematics 410, Digital Computer Systems; or permission of instructor. 3 credits. (Alternate years; offered 1975-76.)

### 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: Forest Resources 711 and Mathematics 410, Digital Computer Systems; or permission of instructor. 3 credits. (Alternate years; offered 1974-75.)

### 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 credits.

### (898), 898. GENETICS SEMINAR

Presentation and discussion of selected genetic topics. Staff. 1 credit. May be repeated.

# Genetics

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**899. MASTER'S THESIS**  
6-10 credits.

**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 (17)

#### 711. COMPARATIVE ANIMAL GENETICS

Consideration of how heredity affects domesticated animals, poultry, other mammals, and fish. Emphasis will be at the level of the organism, but the population, quantitative inheritance, principles of selection, and genetics of resistance to disease will be studied. Statistical and experimental techniques will be discussed. Mr. Collins. Prerequisite: 4 credits of genetics or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

#### 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 credits. (Alternate years; offered in 1975-76.)

### Forest Resources (21)

#### 711. STATISTICAL METHODS II

An intermediate course in statistics. Topics include basic concepts of sampling, linear models and analyses for one-way and multiway classification, factorial arrangement of treatments, multiple regression, and covariance. Mr. Barrett. Prerequisite: Forest Resources 528, Applied Statistics, or equivalent. 4 credits.

#### 720. FOREST TREE IMPROVEMENT

The genetics of forest tree improvement with emphasis on variation in natural populations, the basis for selection for desired characters, and the fundamentals of controlled breeding. The application of principles will be directed toward silviculture, management, and utilization. Mr. Hocker. Prerequisite: permission of instructor. 2 lectures; 1 laboratory; 4 credits. (Alternate years; not offered 1974-75.)

### Microbiology (70)

#### 804. MICROBIAL GENETICS

An introduction to genetic principles and methodology applicable to microorganisms; fine structure of genetic material, mutation, selection, recombination, transformation, transduction, and extrachromosomal inheritance. Mr. Zsigray. Prerequisite: permission of instructor. 2 lectures; 1 laboratory; 4 credits. (Alternate years; offered 1974-75.)

### Plant Science (24)

#### 732. DEVELOPMENTAL GENETICS

Fundamental concepts concerning gene action in relation to development, with emphasis on plant organisms. Topics will include isozymes and differentiation, chromosomal proteins and gene regulation, temporal specificity of gene action, nuclear-cytoplasmic interactions, chemical gradients and gene activation, and gene control of differentiation. Prerequisite: Introductory Genetics and Introductory Physiology. Mr. Loy. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1974-75.)

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

Theory and use of plant breeding systems with emphasis on quantitative plant improvement. Mr. Peirce. Prerequisites: genetics and statistics or permission of instructor. 3 lectures; 3 credits. (Alternate years; offered 1975-76.)

#### 851. PLANT GENETICS

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 credits. (Alternate years; not offered 1974-75.)

#### 853. CYTOGENETICS

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory technique in cytogenetic analysis. Mr. Rogers. Prerequisite: Genetics and Cytology. 2 lectures; 1 laboratory; 3 credits. (Alternate years; offered 1974-75.)

### Zoology (84)

#### 707. HUMAN GENETICS

Inheritance patterns, gene and chromosome mutation rates and effects, linkage, and gene frequency will be emphasized. Prerequisite: Zoology 604 or equivalent, or permission of instructor. 4 credits.

### German and Russian (66 & 67)

**Chairman:** Michael J. Rosenbush

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

**ASSISTANT PROFESSORS:** Guenter Herr, Michael J. Rosenbush,  
James L. Sherman

**DIRECTOR OF GRADUATE STUDIES:** Helmut F. Pfanner

**DIRECTOR OF STUDIES ABROAD:** James L. Sherman

The Department of German and Russian 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 superior command of spoken and written German and be able to demonstrate knowledge of a second, modern, foreign language.

To satisfy the requirements for the degree of Master of Arts, the student must: 1) successfully complete ten courses including two seminars, or 2) complete eight courses successfully and write a master's thesis. The candidate must also pass the departmental comprehensive examination based upon the master's reading list.

A student may take up to 12 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 chairman.

Graduate students must take a minimum of three courses at the 800 level.

#### **725. HISTORY OF GERMAN-SPEAKING COUNTRIES**

A survey of the political, ethnological, and economic history of Germany, Austria, and Switzerland. Offered only in the summer. 4 credits.

#### **726. GERMAN CULTURE AND CIVILIZATION**

A survey of the historical, social, artistic, and folkloristic developments in German-speaking countries from the beginnings to the present. 4 credits.

#### **771. INTRODUCTION TO MEDIEVAL GERMAN LITERATURE**

Reading and critical analysis of selected works of the German High Middle Ages. Texts will be studied in the original and in modern German translation. Offered only in the summer. 4 credits.

#### **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 only in the summer. 4 credits.

#### **773. CLASSICAL PERIOD IN GERMAN LITERATURE**

Reading and critical analysis of selected works; emphasis on Goethe and Schiller. Offered only in the summer. 4 credits.

#### **774. GERMAN ROMANTICISM**

The Romantic movement in German literature from W. Schlegel to Eichendorff including contemporary writers outside the Romantic school, such as Kleist and Hölderlin. Offered only in the summer. 4 credits.

#### **775. THE AGE OF REALISM**

The outstanding prose and lyrics of Keller, Meyer, Storm, Fontane, and others. Offered only in the summer. 4 credits.

#### **776. GERMAN LITERATURE FROM NATURALISM TO EXPRESSIONISM**

Major literary movements between 1880 and 1925 including such authors as Hauptmann, Wedekind, Mann, Hesse, Kafka, Rilke, and Benn. Offered only in the summer. 4 credits.

#### **777. GERMAN LITERATURE FROM 1918 TO 1948**

The literature of Germany between the two world wars as well as German exile literature including Brecht, Doebelin, Zuckmayer, Musil, Broch, Graf, and others. Offered only in the summer. 4 credits.

## History

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### 781. HISTORY AND DEVELOPMENT OF THE GERMAN LANGUAGE

The changes in sounds, structure, and vocabulary of the German language from the earliest record to the present. Required for German majors. 4 credits.

### 792. METHODS OF TEACHING GERMAN

A critical study of modern language teaching at all levels from the elementary school through college. The course emphasizes the use of the most modern equipment, including films, tapes, and other audio-visual aids. Offered in the summer only. 4 credits.

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

Topics to be arranged. Variable to 4 credits. Normally 2 credits counting as 1/2 course. Examples of *typical* courses taught are: Bibliography and Methodology, Influence of German Philosophy on Literature, Phonology, The Structure of Modern German, Renaissance, Baroque, "Biedermeier," Büchner.

### 878. CONTEMPORARY GERMAN LITERATURE

Literary trends since 1948 in the two German states as well as in Austria and Switzerland including such authors as Böll, Johnson, Celan, Frisch, Durrenmatt, Weiss. Offered only in the summer. 3 credits.

### 885-886. GRADUATE STUDIES ABROAD

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

### 888. SEMINAR IN GERMAN LITERATURE

An intensive study of a literary group or figure or a topic dealing with German culture. Offered only in the summer. 3 credits.

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

Presuming a sound background in Germanic studies, this allows the student to investigate independently and in depth a vast range of subjects. Barring duplication of material, this course may be repeated for credit. Offered only in the summer. 3 credits.

### 899. MASTER'S THESIS

6 credits.

## History (68)

**Chairman:** Douglas L. Wheeler

**PROFESSORS:** Thomas N. Bonner, William Greenleaf, Hans Heilbronner, Charles A. Jellison, William R. Jones, David F. Long, Darrett B. Rutman, Cecil J. Schneer

**ASSOCIATE PROFESSORS:** Charles E. Clark, Robert C. Gilmore, Marion E. James, Allen B. Linden, Frank D. McCann, Robert M. Mennel, Marc L. Schwarz, John O. Voll, Douglas L. Wheeler, Donald J. Wilcox

**ASSISTANT PROFESSORS:** Thomas M. Kemnitz, Judith A. Silver

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

### Admission

The department usually requires completion on an undergraduate level of the equivalent of a history major at this University (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, however, reserves the right to assess the student's entire application, including non-quantifiable elements such as letters of recommendation, in making its recommendation 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, however, 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 (i.e., two final course grades below B) is automatically barred from continuing in any degree program in history, but the department reserves the right to exclude others whose over-all performance does not give reasonable assurance of a successful program completion. Students are allowed no more than three attempts to meet any language requirements.

## Degree Programs

The department offers the Master of Arts and Doctor of Philosophy degrees. The general degree requirements are outlined below, but specific programs are tailored to the goals of the student. The director of graduate studies of the department serves as the initial adviser to entering graduate students, the adviser-of-record to all students throughout their years of graduate study, and, with the Graduate Committee of the department, has general supervision of all student programs. By the beginning of a student's second semester in residence, the student intending a degree will ordinarily have selected a single member of the faculty as his program chairman 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.

A student's thesis-examining or guidance committee, as described below, is nominated by the director of graduate studies with the consent of the program chairman and is appointed by the dean of the Graduate School.

### 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; 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

chairman, 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. Three copies of the completed thesis, prepared in conformity with Graduate School regulations, shall be submitted to the reading committee no later than six weeks prior to the Commencement at which the degree is to be granted, and to the director of graduate studies for signature subsequent to approval by the committee and prior to submission to 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 chairman 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 Doctor of Philosophy with concentration in either of the two subfields of American history: Early America or Modern America. The degree is not essentially a course-related degree but is awarded in recognition of high attainment and ability in history as shown by performance in qualifying examination and by the preparation and defense of a dissertation. Normally, a student intending the doctorate who enters without an M.A. in history will complete an M.A. by way of prerequisite and include any of the following not part of undergraduate training: language training to the extent of competence in one foreign language and surveys of American and European historiography equivalent to History 723 and 774. Language proficiency is to be demonstrated by examination administered by the Graduate Student Foreign Language Testing Service, Princeton, N.J., or, if practicable, by a member of the faculty in history. A student in residence may, 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 the specific member of the faculty under whom the student will write the dissertation and who serves as the student's program chairman.

# History

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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 chairman. The program, which must be approved by the Graduate Committee of the department, shall involve each of the following: 1) a second language or a special research technique, whichever is deemed most relevant to the area of research; 2) the entirety of American history with accent upon either of the subfields of Early and Modern America; 3) two subfields outside of American history; and 4) a cognate field outside of history entirely or a subfield of non-western history.

The preparation of the student for qualifying examinations will be guided by representatives of each subfield or cognate field specified. These representatives, as nominated by the director of graduate studies in consultation with the student and program chairman and appointed by the dean of the Graduate School, will constitute the student's Guidance and, subsequently, Examining and Dissertation Committees. Preparation for qualification will normally entail the completion of sixteen semester courses or more (including work undertaken in a master's program) and will require three years of study beyond the bachelor's degree, the greater portion of which is ordinarily accomplished in full residence.

The qualifying examinations will test the student's mastery of broad subfields of historical knowledge rather than of particular courses. Therefore, the student is expected to read widely and independently in order to expand his knowledge beyond formal course work.

The student should progress toward degree in six successive steps. (It is expected that University registration will be maintained during all regular academic semesters the student is in progress.) The steps are:

1. The removal of any existent deficiencies in the undergraduate or master's program.
2. 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.)
3. 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.
4. 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.
5. Submission of an acceptable dissertation no more than three years after the admission to candidacy.
6. 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

Anglo-American from the late sixteenth century to the mid-eighteenth century, encompassing a general and interpretative view of the development of an Anglo-American culture along the eastern seaboard of North America. Mr. Rutman. 4 credits.

### 704. SOURCES AND METHODS OF COLONIAL AMERICAN HISTORY

An introduction to the materials and methodology of the historian of Anglo-America, structured around a series of problems underlying the interpretations considered in 703; specific approaches to these materials; and what historians have done with the materials. Mr. Rutman. Prerequisite: History 703 and (for graduate students) permission of the instructor. 4 credits.

### 705, 706. AMERICAN IN THE EIGHTEENTH CENTURY AND THE REVOLUTION

American Colonial and Revolutionary history during the period from 1740 through the adoption of the Constitution and the establishment of Washington's first administration. Mr. Gilmore. 4 credits.

### 711, 712. NINETEENTH CENTURY AMERICA

The historical factors, both domestic and international, involved 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. Mr. Jellison. 4 credits.

### 715, 716. TWENTIETH 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. Mr. Greenleaf. 4 credits.

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

Primarily the history of American diplomacy, with attention given to the nondiplomatic aspects of foreign relations. Mr. Long. 4 credits.

## 721, 722. HISTORY OF AMERICAN THOUGHT

An examination of the ideas, considered in their social context, of significant American thinkers. First semester, 1600 to 1860. Second semester, 1860 to the present. Mr. Clark, Mr. Mennel. 4 credits.

## 723. AMERICAN HISTORIOGRAPHY

The principal writing of American historians from colonial period to the present time. Emphasis will be given to those works that pertain mainly to the American people and their immediate neighbors. Mr. Jellison. Prerequisite: permission of instructor. 4 credits.

## 724. AMERICAN URBAN HISTORY

The development of urban society in America from colonial times to the present. Lectures will also explore the comparative histories of European and American cities. Mr. Mennel. 4 credits.

## 725, 726. AFRO-AMERICAN HISTORY

Basic historical problems, with reference to the economic, political, and social conditions of black Americans, from the early slave-trade period to recent radical confrontations and the Black Power movement. 4 credits.

## 731. LATIN AMERICAN HISTORY: REGIONAL OR COUNTRY STUDIES

The history of a specified region or country in which directed research papers will be required. It is recommended but not required that participants take History 531-532, Latin American History, as a preparation. See the current department listing for the semester topic. Mr. McCann. 4 credits.

## 732. LATIN AMERICAN HISTORY: TOPICAL STUDIES

A thematic course in which directed research papers will be required. It is recommended but not required that participants take History 531-532, Latin American History, as a preparation. See the current department listing for the semester topic. Mr. McCann. 4 credits.

## 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: the Latin Christian, the Islamic, and the Byzantine. Religious, literary, and scholarly survivals and innovations from 400 A.D. to 1400 A.D. Mr. Jones. 4 credits.

## 741. THE AGE OF THE RENAISSANCE

Renaissance from 1300 to 1600. The course will stress intellectual and cultural history and will concentrate on events in Italy, though aspects of the Renaissance in northern Europe will also be covered. Mr. Wilcox. 4 credits.

## 742. THE AGE OF REFORMATION

The course will cover the period from 1300 to 1600 in northern Europe, stressing the intellectual and cultural aspects of the European Reformation. While the course will concentrate on the events of the sixteenth century, important trends in the fourteenth and fifteenth centuries will be given considerable attention. Mr. Wilcox. 4 credits.

## 747. SEVENTEENTH AND EIGHTEENTH CENTURY FRANCE: THE OLD REGIME

This course will focus on how France changed from a corporate society where most bonds were local to one in which noble and peasant alike identified with the State. Ms. Silver. 4 credits.

## 748. NINETEENTH CENTURY EUROPE: SOCIAL UPHEAVAL AND POLITICAL CHANGE

This course will focus on the tensions between social classes and institutions—the army, the church, the bureaucracy, and education—to see how they affected political development. The main emphasis will be on France. Ms. Silver. 4 credits.

## 749. THE AGE OF REVOLUTION

Revolution as a socio-political phenomenon in its historical setting. Comparative approach to Puritan, American, and French revolutions with reference to contemporary movements. Mr. Gilmore. 4 credits.

## 751, 752. EUROPEAN INTELLECTUAL HISTORY

The development of the European intellectual tradition from the Greek philosophers to the end of World War II. Emphasis is on the way in which basic ideas have developed out of previous modes of thought in response to new challenges. Mr. Wilcox. 4 credits. (Offered in alternate years.)

# History

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## 756. TWENTIETH CENTURY EUROPE

The background of World War I, the inter-war period, the rise of European totalitarianisms, World War II, and the attempts to solve the conflicts of modern society in the post World War II period. Mr. Heilbronner. 4 credits.

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

The Iberian states and their peoples from the coming of liberalism to the present. Why Iberian liberalism and liberal government failed to triumph will be a featured theme. Political and social change will be emphasized and imperial and intellectual movements. In the study of two modernizing countries with persistent traditions, influences of Western European thought and activity will be included. Seminar format. Mr. Wheeler. 4 credits.

## 761, 762. ENGLAND IN THE TUDOR AND STUART PERIODS

An examination of 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. Mr. Schwarz. 4 credits.

## 763, 764. HISTORY OF RUSSIA

The development of the Russian state from its foundation to its present status as a world power. The course is designed to increase the understanding of the present in terms of the past. Political developments, foreign relations, and intellectual and ideological currents. Mr. Heilbronner. 4 credits.

## 767, 768. HISTORY OF GERMANY

Germany and the various German states from the Reformation to the Third Reich and the presently divided Germany. The course will emphasize the relationship and importance of Germany to the rest of Europe. 4 credits.

## 771, 772. MODERN ENGLAND

The history of England from 1760 to the present. Emphasis is placed on the social, intellectual, economic, and political transformation of the country as it developed into a major industrial nation. Mr. Kemnitz. 4 credits.

## 774. EUROPEAN HISTORIOGRAPHY

The development of historical writing from the Greeks to the twentieth century. The course will stress means of evaluating various types of historical writing, the intellectual context of the historians considered and the effect of this on their work. Readings will be from selected historians. The course is neither a methodology course nor one in the philosophy of history, and these problems will not be directly treated. Mr. Wilcox. 4 credits.

## 777, 778. THE HELLENISTIC-ROMAN WORLD

History of the Ancient World from the death of Alexander in 323 B.C. to the end of Constantine's reign in 337 A.D. Major political, economic, and social developments, and consideration of artistic, scientific, philosophical, and religious trends, with particular emphasis on the rise of Christianity and the transformation of the classical world. Ms. James. 4 credits.

## (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 to the present. Mr. Linden. 4 credits.

## 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. Special attention is given to the development of European hegemony. The course will trace the impact of European imperialism, European settler nationalism, African nationalism, racial conflict, economic competition and industrialization, Apartheid, and assimilation. Included will be a discussion of official American policy in this region. Mr. Wheeler. 4 credits.

## 785. THE MODERN MIDDLE EAST

A history of the Middle East from the eighteenth century to the present time, with special attention given to 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. Mr. Voll. 4 credits.

## (787). BLACK CONSCIOUSNESS AND PROTEST

A survey of the origins and cause 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. The course includes: lectures; discussions; and panels on protest literature, black nationalism, Pan-Negroism, Pan-Africanism, *negritude*, the Nation of Islam, and separatist religious sects in the Americas and Africa. The framework will be cross cultural and multi-disciplinary. Mr. Wheeler. 4 credits.

## (789). SEMINAR IN THE HISTORY OF SCIENCE

Selected topics, conducted through special lectures, individual study, and oral and written reports. The subject will vary from year to year. This course is the same as Physical Science (789). *Cannot be used for credit in History without permission of the History Department.* Mr. Schmeer. Prerequisite: permission of adviser and instructor. 4 credits.



## 790. QUANTIFICATION AND COMPUTERS FOR THE HISTORIAN

An introduction to the historian's use of computers and statistics stressing the practical applications of both interactive terminal operations and batch processing. Students will be exposed to data generation and processing, computer languages (Basic, Fortran), programming and library programs, terminal and batch procedures, elementary statistics; 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. Mr. Rutman. 4 credits.

## 791. HISTORY-EDUCATION. PROBLEMS IN THE TEACHING OF HIGH SCHOOL HISTORY AND OTHER SOCIAL STUDIES

Bibliography and new interpretations of history; the social studies curriculum, past and present; aims and objectives in the social studies; selection and organization of teaching material; teaching and testing techniques. Special emphasis on teaching American history and the problems of American democracy. Open to students who have satisfactorily completed History 503, 504; six credits in other history courses, exclusive of History 501, 502; six credits from American government, Principles of Economics, or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. Mr. Draves. 4 credits.

## (793). WORLD HISTORY

History from the perspective of the experience of the whole community. The histories of separate areas will be examined 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. Students will present oral and written reports as a basis for discussions. Mr. Voll. Prerequisite: permission of instructor. 4 credits.

## (797). COLLOQUIA IN HISTORY

Selected topics in American, European, and non-Western history. Staff. Prerequisite: permission of instructor. 4 credits.

## 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 credit.

## (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 credits.

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

(1) (Afro-American), (2) Mr. Greenleaf (Twentieth Century), (3) Mr. Jellison (Nineteenth Century and Biography), (4) Mr. Mennel (Social), (5) Mr. Long (Foreign Relations). Prerequisite: permission of instructor. 3 credits.

## (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 in Neocolonial Latin America; Brazil: Empire and Republic; and Slavery in the Americas: a Comparison. Mr. McCann. 3 credits.

## 843, 844. SEMINAR/READINGS IN EUROPEAN HISTORY

1) Mr. Heilbronner (Modern Russia). 2) Mr. Jones (Medieval). 3) Ms. Silver (France) 4) Mr. Wheeler (Spain and Portugal). 5) Mr. Wilcox (Renaissance).

## (859, 860). SEMINAR IN ENGLISH HISTORY

(1) Mr. Kemnitz (Nineteenth Century), (2) Mr. Schwarz (Tudor-Stuart). Prerequisite: permission of instructor. 3 credits.

## 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 credits.

## Home Economics

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### (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 credits.

### (899). MASTER'S THESIS

### (999). DOCTORAL RESEARCH

## Home Economics (22)

**Chairwoman:** Elizabeth Snell

ASSOCIATE PROFESSORS: M. Elizabeth Rand, Emeritus, Mary E. Holder, Elizabeth A. Snell

ASSISTANT PROFESSORS: Larry J. Hansen, Victor R. Messier, Judith A. Schickedanz

Graduate work is offered leading to the degree of Master of Science in Home Economics, with major emphasis in areas which strengthen professional competence in family, community, and educational services.

Each student's program will be planned to achieve personal and professional objectives of the individual and be based on specific interests, ability, and undergraduate preparation. Selection of courses from the social sciences and other University departments will be encouraged.

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.

A candidate for a Master of Science degree in Home Economics is expected to fulfill the general requirements of the Graduate School and the following departmental requirements:

1. Home Economics—a minimum of 12 semester credits (700 level and above).

2. A minimum of eight semester credits selected from the liberal arts or other areas which support the major.

3. Research and Statistics—a minimum of eight semester credits, including Home Economics 897, Research Seminar; a course in statistics; and Home Economics 898, Research Project, or Home Economics 899, Thesis.

Each student must have his program approved by his adviser and the dean of the Graduate School.

### 707. PRACTICUM WITH CHILDREN AND FAMILIES

A planned, supervised experience with children or families at both participating and observing levels. The practicum is designed to increase the students' awareness and understanding of the ways human beings grow and behave and the dynamics of the family and community settings. Weekly class discussions will be combined with individual and small-group supervisory conferences. Students have the opportunity to choose a focus for their practicum from among the following: 1) young children-preschool program, 2) school-age children, 3) adolescents, 4) children and parents, and 5) low-income families-management experiences. Limited to Home Economics majors. Prerequisite: Home Economics major and permission of department. One or more semesters, 2 or 4 credits, maximum of 6 credits in one area.

### 715. CLOTHING IN RELATION TO HUMAN BEHAVIOR

The analysis of research and theory in the social-psychological aspects of clothing. An exploration and study of clothing behavior of individuals and groups. Special emphasis given to stages of the life cycle, development of the self, and the phenomenon of fashion. 4 credits.

### 725. PRESCHOOL PROGRAMS

A study of the organization and operation of programs for young children. Theoretical knowledge about children and educational techniques will be related to the curriculum, facilities, and administration in a variety of group programs for young children. Field trips will be planned. Prerequisite: Home Economics 627, Creative Activities in Preschool Programs, or equivalent. Limited to Home Economics majors, or permission of instructor. 4 credits.

### 754. PERSONAL AND FAMILY FINANCE

A study of major financial alternatives available to individuals and families during the various stages of the family life-cycle. 4 credits.

### 757. CONSUMER PROBLEMS

A model for analyzing consumer problems from the perspective of family, business, and government interests. The application of theoretical knowledge to the solution of consumer problems. Prerequisite: 8 credits in consumer studies and permission of instructor. 4 credits.

# Institute of Natural and Environmental Resources

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## 774. NUTRITION AND DISEASE

Application of the principles of normal nutrition to clinical problems, with a description of altered nutrient requirements in human disease. Diet therapy as an applied aspect of clinical nutrition is considered. A practicum in a field situation will be a part of the experience. Prerequisite: Home Economics 573, Human Nutrition, or equivalent. 4 credits.

## 776. NUTRITION-A WORLD VIEW

Study of the major nutritional problems facing the world today. Consideration of protein-calorie malnutrition, obesity, nutritional status of adolescents, and special nutritional problems of pregnancy, infancy, childhood, and the aging. An exploration of concepts and methodologies for nutrition education. Prerequisite: Home Economics 573, Human Nutrition, or equivalent. 4 credits.

## 786. DYNAMICS OF FAMILY CHANGE

An examination of the theories and supporting research of the intervention techniques used to effect changes in family behavior. Prerequisite: Home Economics 683, Family Relations, and Psychology 545, Clinical Approaches to Human Behavior, or permission of instructor. 4 credits.

## 791, (791). METHODS OF TEACHING FAMILY LIFE AND HOME ECONOMICS

Home economics education in the school program, curriculum materials, methods, and resources in teaching home economics. 4 credits.

## 793. SEX EDUCATION IN HOME, SCHOOL, AND COMMUNITY

An exploration of human sexuality and of programs, materials, and methods for sex education in home, school, and community. Issues, community mores, goals, and values will be examined. Planned for school personnel, parents, and others working with children, youth, and families. 4 credits.

## 883. HUMAN SEXUAL BEHAVIOR

An exploration of contemporary opinion and research on human sexual behavior and development. The implications for social welfare and education will be examined in light of available research and other scholarly studies. 4 credits.

## 892. METHODS IN FAMILY RELATION EDUCATION

A study of the methods and materials used in family relations education in high schools, colleges, churches, and social agencies. The methods will be applied through role play and field experience. The course assumes mastery of the basic principles of family relations, human development, and theories of intervention. 4 credits.

## 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 credits.

## 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 credits.

## 898. RESEARCH PROJECT

A study or project which may be selected in lieu of a thesis. To be taken concurrently with or following Home Economics 897. 2-4 credits.

## 899. THESIS

6 credits.

## Institute of Natural and Environmental Resources

**Director:** David P. Olson

**Chairman of Graduate Studies:** John L. Hill

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

**ADJUNCT PROFESSOR:** George E. Frick

**ASSOCIATE PROFESSORS:** Owen B. Durgin, Bennett B. Foster, Edmund F. Jansen, Jr., 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, Nelson L. LeRay, Robert S. Pierce

**ASSISTANT PROFESSORS:** Robert D. Harter, H. Steven Logsdon, William W. Mautz, Douglas E. Morris

**ADJUNCT ASSISTANT PROFESSOR:** Peter W. Garrett

# Institute of Natural and Environmental Resources

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

### Soil Science

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

### 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 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 two or more courses in economics or resource economics and a total of four or more courses in the social sciences. 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.

## 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 Technology, 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 (27)

### 701. STATISTICAL METHODS I

An introduction to the analysis of variance and general linear models. Topics will include measured numbers, the nature of statistical evidence, sampling distributions, and principles of statistical inference. Emphasis will be on the application of specific linear models to given sets of data. Prerequisite: upper division undergraduate or graduate standing. Mr. Durgin. 4 credits.

# Institute of Natural and Environmental Resources

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## 702. NATURAL RESOURCES POLICY

Contemporary issues in the management and allocation of natural resources. The impact of human activity and demands on resources including: agricultural and forest lands, water, wildlife, fisheries, and minerals. Historical perspective as it contributes to an understanding of current public and private resource policies. Mr. Bruns, Mr. Weyrick, Mr. Bowring, Mr. Drew. Prerequisite: permission of instructor. 4 credits.

## 709. SOILS AND COMMUNITY PLANNING

A "Town Plan" and a soils map are studied by students to develop individual reports of land use. Introduction to the soils of New Hampshire, basic information on the U.S.D.A. soil classification system, and the Soil Conservation Service criteria for rating soils for multiple use; housing, recreation, sewage-effluent disposal, conservation, transportation, surface runoff, and other soil-use problems common to many rural and urban communities. A representative of a town planning firm and federal and state soil scientists are guest lecturers. Mr. Peterson. 2 lectures; 2 credits.

## 711. STATISTICAL METHODS II

An intermediate course in statistics. Topics include basic concepts of sampling, linear models, and analyses for one-way and multi-way classifications; factorial arrangement of treatments; multiple regression; and covariance. Computer programs used in analyzing data. Mr. Barrett. Prerequisite: INER 528, Applied Statistics, or equivalent. 4 credits.

## 712. SAMPLING TECHNIQUES

A study of the techniques of sampling a finite population. Topics include choice of sampling unit and frame, estimation of sample size, confidence limits, and comparisons of sample designs. Computer programs used in analyzing data. Mr. Barrett. Prerequisite: INER 528, Applied Statistics, or equivalent. 4 credits.

## 735. POLLUTION OF WATER: CAUSES AND CONTROL

A combination of individual study and guided classroom discussion to explore problems in environmental pollution. Major emphasis is on the scientific and technological aspects of pollution and pollution control. Topics include the sources, effects, and control of water pollution; as well as its social, economics and legal implications. Mr. Harter. Prerequisites: senior or graduate standing or permission of instructor. One lecture and weekly papers. 4 credits.

## 753. OPERATIONS CONTROL AND ANALYSIS

Theory and use of the more important quantitative tools used to aid decision-making in natural resource based production activities. Development and analysis of cost functions, forecasting, linear programming, Monti Carlo simulation, PERT. Transportation fee. Prerequisites: Computer use and programming; Micro-Economics; F.R. 544, Elementary Statistics. Mr. Foster. 3 lectures; 1 laboratory; 4 credits.

## 758. REMOTE SENSING

Imaging with photographic and non-photographic sensors. Emphasis is on the interpretation of aerial photography and on conventional photogrammetric techniques. Applications of remote sensing to resources management including forestry, agriculture, geology, engineering, and land-use planning. Transportation fee. Field and indoor laboratory work arranged to fit the disciplinary interest of the student. Mr. Bruns. 3-hour lecture; 3-hour laboratory; 4 credits.

## 797. FOREST RECREATION SEMINAR

The recreational use of forest lands, including factors that affect demand and supply for recreation. Planning for state and local recreational use, emphasizing the economic and social aspects. Mr. Wallace. Prerequisite: junior standing and permission of instructor. Two 2-hour sessions; 4 credits.

## 803. APPROACH TO RESEARCH

The meaning of science and the scientific method. The application of logic in the scientific method. The general principles and techniques of scientific research. A general survey of statistical procedures as a tool for research. The organization of investigative work including problems analyses, working plans, and the preparation of reports. Mr. Drew, Mr. Hill, Mr. Hall. Prerequisite: permission of instructor. 2 credits.

## 806. OPERATIONS CONTROL SEMINAR

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of quantitative control of forest operations. Mr. Foster. Prerequisite: permission of instructor. 2-hour seminar; 2 credits.

## 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. Applications to firm and aggregate economic analysis. Mr. Andrews. Prerequisite: Elementary Matrix Algebra or permission of instructor. 2 credits.

# Institute of Natural and Environmental Resources

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## 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 credit.

## Forest Resources (21)

### 720. FOREST TREE IMPROVEMENT

The genetics of forest tree improvement with emphasis on variation in natural populations, the basis for selection of desired characters, and the fundamentals of controlled breeding. The application of principles will be directed toward silviculture, management, and utilization. Mr. Hocker. Prerequisite: permission of instructor. 3 lectures; 1 laboratory; 4 credits. (Alternate years; not offered in 1974-75.)

### 737. GAME MANAGEMENT I

Biological characteristics, habitat usage, research, and management techniques of upland game birds and big game mammals. Students should be prepared for weekend field trips to wildlife areas in New England. Transportation fee. Mr. Olson. Prerequisite: wildlife management major or consent of instructor. 2 lectures; 1 recitation; 1 laboratory; 4 credits.

### 738. GAME MANAGEMENT II

Biological characteristics, habitat usage, research, and management techniques of *small game mammals, furbearers, and waterfowl*. Students should be prepared for weekend field trips to wildlife areas in New England. Transportation fee. Mr. Olson. Prerequisite: wildlife management major or consent of instructor. 2 lectures; 1 recitation; 1 laboratory; 4 credits.

### 745. FOREST MANAGEMENT

Production control in forests with many uses and management objectives. Analysis of silvicultural, economic, and business problems. Practice of forest administration. Professional responsibilities and opportunities. Mr. Weyrick. Transportation fee. Prerequisite: completion of junior year in forestry program or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

### 754. WOOD-PRODUCTS MANUFACTURE AND MARKETING

A study of the wood-products manufacturing industry from the harvesting and procurement of raw material to finished product with emphasis on management decisions, marketing, and promotion problems. Visits to harvesting operations and manufacturing plants in New England. Transportation fee.

Mr. Hill. Prerequisite: Forest Resources 426, Wood Technology. 3 lectures; 1 laboratory; 4 credits.

### 764. FOREST INDUSTRY ECONOMICS

Application of business methods and economics in the establishment and operation of forest industries; planning for minimum-cost operation and the profitable use of capital in forest enterprises. Mr. Wallace. Prerequisite: senior standing and permission of instructor. 4 credits.

### 798. FOREST RESOURCES MANAGEMENT SEMINAR

Population trends and human needs in relation to forestland productivity for timber, wildlife, water, recreation, and grazing. Organized groups involved in forest-land use and management, and overall planning to help maximize forestland use and productivity for our society. Mr. Wallace. Prerequisite: Forest Resources 745. 4 credits.

### 801, 802. FOREST MANAGEMENT SEMINAR

Seminar discussions of current literature, plans, and principles, and new developments in the general field of forest management. Mr. Bruns and members of the department. Prerequisite: permission of instructor. 2 credits.

### 805. UTILIZATION SEMINAR

Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. Mr. Hill. Prerequisite: permission of instructor. 2-hour seminar; 2 credits.

### 809, 810. WILDLIFE MANAGEMENT SEMINAR

Discussions and assigned reports on current investigations and developments in wildlife management. Mr. Olson, Mr. Mautz, and Mr. Logsdon. Prerequisite: undergraduate courses in wildlife management. 2-hour seminar; 2 credits.

### 815. ADVANCED MENSURATION

Volume-table construction and application, advanced studies of growth and yield, and methods of prediction. Application of graphic and statistical solutions to these problems. Mr. Barrett. Prerequisite: Forest Resources 644, Forest Biometrics, or permission of instructor. 2 lectures; 1 laboratory; 2 or 4 credits.

### 833. FOREST PROTECTION SEMINAR

Discussion and special problems based on principles and techniques of forest protection. Mr. Weyrick. Prerequisite: Forest Resources 660, Forest Protection, or courses in entomology or plant pathology. 3 credits.

# Institute of Natural and Environmental Resources

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**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 credits.

## **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 credits.

## **Resource Economics (25)**

### **705. PLANNED CHANGE IN NON-URBAN COMMUNITIES—APPLICATION**

Application of community development theory, concepts, and principles using appropriate research methodologies. Student designed projects provide for participation in community development activities. Weekly synthesizing seminar sessions provide a forum for discussing student problems and reporting on findings, experience, and progress. May include placement in field agency or institution. Mr. LeRay. Prerequisite: Resource Economics 508 or permission of instructor. 4 credits.

### **706. ECONOMICS OF RESOURCE DEVELOPMENT**

The classical and modern theories of economic development. Economic problems of land and resources in relation to market location, urban-rural conflicting demands, and conservation and water supply. Population mobility, capital needs, and the roles of public and private leadership will complete the framework for discussion of the major resource development problems of New England. Mr. Bowring. Prerequisite: Principles of Economics or equivalent. 4 credits.

### **707. RESEARCH METHODS IN SOCIAL SCIENCE**

The scientific method of research, analysis of research problems in social sciences. The design of research and the application of research techniques to identifying and solving problems. Mr. Drew. Prerequisite: 3 hours of statistics. 4 credits.

### **717. LAW OF COMMUNITY AND REGIONAL PLANNING**

A review of the law pertaining to community and regional planning as evidenced by the Common Law, the Constitution, and the powers of the executive, legislative, and judicial branches

with respect to property law including eminent domain, land-use planning, urban renewal, zoning, environmental protection laws, housing, and building codes, etc. The course is designed to make the non-lawyer better aware of the influence and operation of the legal system. Mr. Tucker. 4 credits.

### **756. REGIONAL ECONOMIC ANALYSIS**

Concepts and methods of delimiting regional economies, theories of regional growth, methods of measuring regional economic activity, empirical approaches to regional economic planning and development, and public policies for regional economies. Although theoretical aspects of regional economics will be considered, primary emphasis will be placed on empirical research studies and their policy implications for regional economic performance. Mr. Morris. Prerequisite: intermediate economic theory, elementary statistics, elementary calculus, elementary linear programming, or permission of instructor. 4 credits.

### **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 and Mr. Morris. Prerequisite: INER 701 or equivalent, and Economics 605 or equivalent. 4 credits.

### **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 credits.

### **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 credits.

### **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.

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Andrews, Mr. Jansen, Mr. Morris, and Mr. Henry. Prerequisites: Economics 605 and 611, or equivalent, and permission of instructor. 2 credits.

## 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 credits.

## 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 to 4 credits.

## 899. THESIS

To be arranged. 6-10 credits.

## Soil and Water Science (26)

### 701. PHYSICS OF SOILS

The treatment of soil as a physical system. Major topics include: textural and structural analysis of soils, water flow and retention, heat and gas transfer processes in soils. The influence of soil physical-properties on plant growth is also covered. Laboratory sessions deal with methods of soil physical analysis. Prerequisite: Soil and Water 501, Introductory Soils, or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

### 702. CHEMISTRY OF SOILS

Chemical properties of soils in relation to their composition and use as a vital resource. Colloidal phenomena and their relation to exchange and fixation of elements in soil. Major topics include: cation exchange capacity and source of negative charge, the nature of soil acidity, the chemistry of nitrogen and phosphorus in the soil, and modern methods of soil chemical analysis. Mr. Harter. Prerequisite: quantitative analysis or permission of instructor. 3 lectures; 3 credits.

### 703. SOIL AND WATER ENGINEERING

The treatment of engineering principles relating to the control of water. Major topics include precipitation and stream-flow measurement, hydrograph development, estimating run-off from a watershed and the design of structures to control this run-off. Laboratory sessions are designed to acquaint the student with instrumentation and problem analysis. Mr. Byers. 3 lectures; 1 laboratory; 4 credits.

### 704. SOIL CLASSIFICATION AND MAPPING

The genesis, morphology, classification, and mapping of soils with emphasis on major classification systems used in the United States and throughout the world as they relate to man's uses of the soil. Transportation fee. Mr. Peterson. Prerequisite: Soil and Water 501, Introductory Soils, and an introductory geology course, or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

### 705. PRINCIPLES OF HYDROLOGY

Physical and chemical processes and energy relations involved in the movement of water through the rainfall-runoff segment of the hydrologic cycle. Major emphasis is on surface outflow from a watershed with consideration given to sediment transport, nutrient cycling, and water quality. Laboratory sessions include flow measurement, hydrometeorologic measurements, hydrograph analysis, and study of a selected watershed. Mr. F.R. Hall. 3 lectures; 1 laboratory; 4 credits.

### 710. GROUND-WATER HYDROLOGY

Introduction to the principles governing the occurrence, location, and development of ground water. Major topics include: well hydraulics, geophysical exploration, and chemical quality of water. Brief treatment given to water law and economics. Laboratory sessions are designed to illustrate principles by use of fluid and electrical models, geophysical instruments, and selected problems. Mr. Hall. Prerequisite: Soil and Water Science 703 or permission of instructor. 3 lectures; 1 laboratory; 4 credits.

### 801. ADVANCED SOIL PHYSICS

The physics of unsaturated water flow. Theory of infiltration and drainage. Application of unsaturated water-flow theory to soil-plant-atmosphere systems. Prerequisite: permission of instructor. 3 lectures; 3 credits.

### 802. CHEMISTRY OF SOIL COLLOIDS

Physical chemistry of soil colloids and soil colloidal phenomena. Major topics include: electric double-layer theory, solid-



solution interfacial reactions, surface acidity, theories of swelling, ionic diffusion in soil. Mr. Harter. Prerequisite: one year of physical chemistry or permission of instructor. 3 lectures; 3 credits.

### 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 groundwater 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. F.R. Hall. 3 credits.

### 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 lectures; 1 laboratory; 3 credits.

### 895-896. INVESTIGATIONS IN SOIL AND WATER SCIENCE

Offered in: 1) Soil-Plant Relationships, Mr. Peterson; 2) Physics of Soils; 3) Hydrology, Mr. Byers and Mr. Hall; 4) Chemistry of Water, Mr. Hall; 5) Chemistry of Soils, Mr. Harter; 6) Soil Classification, Mr. Peterson. Elective only after consultation with the instructor in charge. 1-4 credits.

### 899, (899). MASTER'S THESIS

6-10 credits.

## Mathematics (51)

**Chairman:** 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, James A. Radlow, Shepley L. Ross, Robert J. Silverman

**ASSOCIATE PROFESSORS:** Homer F. Bechtell, Albert B. Bennett, Jr., William E. Bonnace, David M. Burton, Loren Meeker, Eric A. Nordgren, Samuel D. Shore

**ASSISTANT PROFESSORS:** William Geeslin, Kenneth L. Lange, Berrien Moore III, Albert O. Shar, Donovan Van Osdol

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. 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;

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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.

**Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.**

## 611. ASSEMBLER LANGUAGE PROGRAMMING

Study of 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. Computer projects to illustrate programming techniques. Prerequisite: Math 410 (or 510). 4 credits.

## 612. DATA STRUCTURES AND PROCESSES

Programming techniques and program structure utilizing a higher-level language such as PL/I. Procedures, blocks, groups, list processing, and string processing. Data organization, record-oriented and stream-oriented data transmission, conversion techniques, and storage allocation. Organization of data structures, areas, structure mapping, pre-processing techniques, linkage with other language modules, and conditions and interrupt processing. Laboratory work includes computer solution of illustrative problems. Prerequisite: Math 611. 4 credits.

## 636. PROBABILITY AND STATISTICS

Sample spaces (discrete only), events, combinations, conditional probability, independence, distributions, expectations, statistical description, random variables, sampling, estimation, tests, and applications of statistics in research. Good for major credit in Mathematics-Education only. 4 credits.

## 645-646. ANALYSIS FOR APPLICATIONS

Real functions; uniform convergence; matrix algebra; special functions; second order ordinary differential equations; Sturm-Liouville problems; Green functions; Fourier expansions. Prerequisites: Mathematics 527 and 528. 4 credits.

## 647. COMPLEX ANALYSIS FOR APPLICATIONS

Complex numbers; complex integration; infinite series; contour integration; conformal mapping; Fourier and Laplace

transforms; Weiner-Hopf techniques. Prerequisites: Math 528, Differential Equations. 4 credits.

## 656. INTRODUCTION TO NUMBER THEORY

Unique factorization, linear and quadratic congruences, quadratic reciprocity law, arithmetic functions, quadratic forms, and introduction to algebraic numbers. Prerequisite: Mathematics 531. 4 credits. (Alternate years; offered in 1974-75.)

## 657. GEOMETRY I

Fundamental properties of Euclidean geometry from an advanced standpoint. Prerequisite: Mathematics 531. 4 credits.

## 658. GEOMETRY II

Systems of postulates of various geometries, geometric invariants, synthetic and analytic projective geometry, introduction to non-Euclidean geometry. Prerequisite: Mathematics 531. 4 credits. (Alternate years; offered in 1975-76.)

## 682. NON-LINEAR DIFFERENTIAL EQUATIONS

Phase plane analysis of linear and non-linear autonomous systems; critical points; limit cycles; periodic solutions; approximate methods for second order, non-linear, ordinary differential equations; stability and asymptotic behavior of solutions of linear and non-linear equations. Prerequisite: Mathematics 527. (Differential Equations). 4 credits. (Alternate years; offered in 1975-76.)

**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; their components, operating characteristics, and limitations. Examines the software organization of computer systems. Overall structure of multiprogramming systems, implementation techniques for parallel processing, study of problems arising in design and management, and system accounting. Study of design of system modules and interfaces. Prerequisite: Math 611. 4 credits.

## 711. PROGRAMMING LANGUAGES AND COMPILER CONSTRUCTION

Introduction to recursive processes; a sketch of PL/L and ALGOL. Foraml syntax and Backus-Naur form, syntax directed compilers, semantic routines, symbol table structures, resource allocation, parsing algorithm, code generation, and optimization of translator writing systems. Associated computer laboratory work. Prerequisite: Mathematics 710. 4 credits.

## 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: Mathematics 528, Multidimensional Calculus. 4 credits.

## 736. STATISTICS

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

## 753-754. NUMERICAL METHODS AND COMPUTERS

This course is oriented toward the use of numerical analysis on digital computers (with laboratory). Computer organization, algorithmic languages and compilers, solution of polynomial and transcendental equations, numerical solutions of differential equations, linear systems of equations, eigenvalues and eigenvectors, polynomial interpolation, quadrature, curve fitting, discussion of errors, systems simulations, and mathematical optimization techniques. Selected algorithms will be programmed for solution on high-speed computers in the Computation Center. Prerequisite: 753—Mathematics 410, Digital Computer Systems, and 426, Calculus II, and 754—Mathematics 410 and 527, Differential Equations. 4 credits.

## 761. ABSTRACT ALGEBRA

A study of the basic properties of groups, rings, fields, and their homomorphisms. Prerequisite: Math 531, Introduction to Abstract Mathematics. 4 credits.

## 762. LINEAR ALGEBRA

Vector spaces, linear transformations, matrices, determinants, dual spaces, eigenvalues, spectral and canonical decomposition theorems. Cannot be taken for credit if credit received for Mathematics 645. Prerequisite: Math 761. 4 credits.

## 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 credits. (Offered in alternate years; offered in 1974-75.)

## 767. ONE-DIMENSIONAL REAL ANALYSIS

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

## 768. ABSTRACT ANALYSIS

Metric spaces, function spaces, theory of uniform limits. Prerequisites: Math 767. 4 credits. (Offered in alternate years, offered in 1975-76.)

## 769. MULTIDIMENSIONAL REAL ANALYSIS

Partial derivatives, multiple integrals, line and surface integrals, Fourier series. Prerequisite: Math 767. 4 credits. (Offered in alternate years; offered in 1974-75.)

## 776. LOGIC

Development of formal mathematics. Discussion within that system of formal systems. Consistency, completeness, decidability. Prerequisite: consent of the instructor. 4 credits. (Offered in alternate years; offered in 1975-76.)

## 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: Mathematics 767. 4 credits. (Offered in alternate years; offered in 1974-75.)

## 784. TOPOLOGY

Basic topological notions, connectedness, compactness, metrizability, with special emphasis on the real line and plane. Prerequisite: Mathematics 510. 4 credits.

## 785. ALGEBRAIC METHODS IN TOPOLOGY

Topics to be selected from: topology of manifolds, topological groups, homology, knot theory. Prerequisite: Math 784. 4 credits. (Offered in alternate years; offered in 1975-76.)

## 786. CALCULUS ON MANIFOLDS

Differentiable manifolds; differential forms; exterior and Grassman algebras; integration of differential forms; Stokes theorem; closed and exact differential forms. Cannot be taken for credit if credit received for Mathematics 769. Prerequisites: Math 762 and 767. 4 credits. (Offered in alternate years; offered in 1974-75.)

## 787. DIFFERENTIAL GEOMETRY

Introduction to Lie Groups and frame bundles; differential invariants of surfaces and curves; local theory of surfaces. Prerequisite: Math 786. 4 credits. (Offered in alternate years; offered in 1974-75.)

# Mathematics

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## 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, and conformal mapping. Cannot be taken for credit if credit received for Mathematics 647. 4 credits.

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. FUNDAMENTAL CONCEPTS OF MATHEMATICS FOR TEACHERS

An introduction to the most fundamental concepts of analysis, geometry, and algebra. Basic elements of set theory; a survey of the real and complex number systems; the integers and the concept of an integral domain; introduction to groups; geometrics, Euclidean and non-Euclidean; functions, sequences, and the limit concept; the derivative and the differentiation of algebraic functions. 3 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 809. PROBABILITY AND STATISTICS FOR TEACHERS

Permutations and combinations; finite sample spaces; random variables; binomial distributions; statistical applications. 3 credits.

## 810. MATHEMATICS EDUCATION

1). Current Developments and Issues in Mathematics Education. A workshop focused on selected mathematics curriculum development projects such as SMSG, UICSM, the Madi-

son Project, SIV-CSMP, the Nuffield Project, and issues such as those represented by the Cambridge conference, the role of mathematics laboratories, the integration of science and mathematics courses, computer-assisted instruction, the role of computers. 2) Teaching of Mathematics. A seminar focused on the introduction of mathematical ideas from the subject-matter courses (801-802, 805-806, 807-808, 826, 829) into the school curriculum with particular emphasis placed on teaching in the secondary school. 1-4 credits.

## 811. COMPUTERS AND THEIR USES

Computing machines and modern numerical methods. Each student will have an opportunity to make use of the University computer. 3 credits.

## 814. TOPOLOGY FOR TEACHERS

Fundamental concepts of elementary topology; network and map problems; sets, spaces, and transformations. 3 credits.

## 816. THEORY OF NUMBERS FOR TEACHERS

Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. 3 credits.

## 817. THEORY OF SETS AND ELEMENTARY LOGIC

An introduction. 3 credits.

## 819. THE REAL NUMBER SYSTEM

A postulational approach. Brief discussion of algebraic structures. Introduction to the sequences, limits, and continuity. 3 credits.

## 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 credits.

## 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 credits.

## 825. INTERNSHIP

Experience under the direction of a master teacher in teaching university level mathematics to superior high school students. This work will be done in the Advanced Studies Program at St. Paul's School, Concord, New Hampshire. 6 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

**The following are the basic courses for both the Master of Science and Doctor of Philosophy degrees in Mathematics.**

## 833-844. ALGEBRA.

Groups; rings; modules; fields; linear algebra. 3 credits.

## 835. MEASURE AND INTEGRATION

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

## 836. FUNCTIONAL ANALYSIS

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

## 837-838. COMPLEX ANALYSIS

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

## 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 credits.

## 841-842. ALGEBRAIC TOPOLOGY

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

**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

Algebraic number theory; algebraic geometry; ring theory; theory of modules; group theory; non-associative algebras. 3 credits.

## 863, 864. TOPICS IN ANALYSIS

Measure theory; calculus of variations; integral equations; boundary-value problems; orthogonal series; theory of approximation; analytic number theory; Riemann surfaces. 3 credits.

## 865, 866. TOPICS IN TOPOLOGY

Algebraic topology; theory of sheaves; dimension theory; Riemann surfaces; homotopy theory. 3 credits.

## 867, 868. TOPICS IN GEOMETRY

Convexity; projective geometry; differential geometry; tensor analysis. 3 credits.

## 869, 870. TOPICS IN FUNCTIONAL ANALYSIS

Rings of functions; linear topological spaces; topological algebras; Hilbert spaces, rings of operators; topological groups; Lie groups; harmonic analysis. 3 credits.

## 871, 872. TOPICS IN DIFFERENTIAL EQUATIONS

Boundary value problems; asymptotic behavior and stability theory; nonlinear equations; dynamic systems; classical theory of partial differential equations; functional analysis and partial differential equations. 3 credits.

## 873, 874. TOPICS IN APPLIED MATHEMATICS

Linear and dynamic programming; differential equations; special functions. 3 credits.

## 875, 876. TOPICS IN PROBABILITY AND STATISTICS

Stochastic processes. 3 credits.

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## 877, 878. TOPICS IN LOGIC AND FOUNDATIONS

Deductive systems; set theories; recursive functions; undecidability; model theory. 3 credits.

## 879, 880. TOPICS IN MATHEMATICS EDUCATION

A detailed analysis of selected problems and issues of current concern in the area of mathematics education, especially the nature and role of mathematics, current curricula, teaching methods, evaluation, problem solving, research design, and research results. 3 credits.

## 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. 3-6 credits.

## 999. DOCTOR OF PHILOSOPHY THESIS

# Mechanical Engineering (52)

**Chairman:** William Mosberg

**PROFESSORS:** Victor D. Azzi, Robert W. Corell, Godfrey H. Savage, Charles K. Taft, Asim Yildiz

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

**ASSISTANT PROFESSORS:** Barbaros Celikkol, David E. Limbert

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, a student should have completed work equivalent to that required at the University of New Hampshire for a Bachelor of Science degree in his 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 71.

Students completing degree requirements through the University Extension Service 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

A continuation of the study of thermodynamic principles using an analytic postulational approach and Legendre transformations to obtain the thermodynamic potentials. 4 credits.

## 702. STATISTICAL THERMODYNAMICS

An introduction to statistical thermodynamics. 4 credits.

## 703. HEAT TRANSFER

Analysis of heat transfer phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. 4 credits.

## 704. EXPERIMENTAL HEAT TRANSFER

Experimental methods in the study and solution of heat transfer problems, including a critical comparison with analytical and other methods. Literature surveys and written and oral presentation of results will be emphasized. 4 credits.

## 707. ANALYTICAL FLUID DYNAMICS

An analytical study of the dynamic behavior of fluids. Topics include potential flow, development of the Navier-Stokes equations, turbulence, and boundary layer theory. 4 credits.

## 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. 4 credits.

## 715. INTERNAL COMBUSTION ENGINES

Application of basic and engineering science to the engineering problems of spark and compression ignition engines; design, management, and reporting of experimental studies. 4 credits.

## 716. PROPULSION SYSTEMS

Application of basic engineering sciences to the engineering problems of propulsion systems. 4 credits.

## 717. CRYOGENICS

The phenomena and processes associated with very low temperatures. Application of basic engineering sciences to the problems of low-temperature refrigeration, liquefaction, separation, storage and transport of cryogenic fluids; measurement systems; vacuum technology. 4 credits.

## 723. ADVANCED DYNAMICS

A traditional course in classical mechanics with an orientation 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 credits.

## 724. INTRODUCTION TO VIBRATIONS

The theory of discrete vibrating systems is treated in depth. Review of linear system concepts and detailed treatment of the single degree of freedom system with general excitation. Matrix and eigenvalue problems. Many degrees of freedom, normal mode theory for free and forced vibration. Numerical methods. Introduction to continuous systems. Applications are made to both structural and mechanical systems. 4 credits.

## 726. EXPERIMENTAL MECHANICS

Experimental methods and their underlying theoretical bases are developed and applied to the measurement of stress, strain, and motion. Topics covered include transmitted and scattered light photoelasticity, strain gage applications, brittle coating and grid techniques, dynamic measurements, and associated instrumentation. 4 credits.

## 727. ADVANCED MECHANICS OF SOLIDS

Advanced topics in the mechanics of solids are treated in depth; beams on elastic foundation, curved bars, inelastic behavior, instability, introduction to thin plates and shells, introduction to elasticity, energy methods, and numerical methods. 4 credits.

## 730. MECHANICAL BEHAVIOR OF MATERIALS

The elastic and inelastic behavior of materials, both organic and inorganic, is studied from the micromechanics and macro-mechanics points of view. Concepts of stress, strain, and constitutive relations are reviewed and related to recent developments in dislocation theory and other phenomena on the atomic scale and to continuum mechanics on the macroscopic scale. Mechanical behavior including elasticity, plasticity, viscoelasticity, creep, fracture, and damping will be treated. Anisotropic and heterogeneous materials such as composite materials will be studied in detail. 4 credits.

## 737. OCEAN MECHANICS I

Ocean as a continuous medium; its mechanical and thermodynamical properties are presented. Shallow and deep ocean modeling for the investigation of gravity waves and sound waves along with the varying mechanical and thermodynamical properties is discussed. Ocean subbottom and its soil mechanical as well as sound propagation properties are introduced. Ocean instrumentation and rudimentary data collecting and processing procedures are given and computer usage is emphasized. Prerequisite: ME 523, 524; ME 508; Math 527, 528. 4 credits.

## 738. OCEAN MECHANICS II

Ocean dynamical laws will be generalized to include temperature and salinity variations in the water column. Conservation laws with generalized equation of state will be developed into coupled partial differential equations which describe temperature and density fluctuation of the media. Air-sea interaction, wave motion with amplitude and phase analysis, and energy transport phenomena, reflection from different coastal geometry, harbor resonances, internal currents are given. Sound reflection from subbottom, sound probing techniques to determine subbottom properties by ray theory is discussed, and subbottom soil from an elastic to a viscoelastic generalization is given. Prerequisites: Mechanical Engineering 737. Mechanical Engineering 781 is desirable but not required. 4 credits.

## 741. CONTROL OF PHYSICAL 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 credits.

# Mechanical Engineering

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## 751. NAVAL ARCHITECTURE IN OCEAN ENGINEERING

Naval architectural principles related to surface and submerged vehicles are developed—including hydrostatic characteristics, fundamentals of powering, and rules and regulations of importance to this aspect of ocean engineering. Prerequisites: Mechanical Engineering 508, Fluid Dynamics, or permission of instructor. 4 credits.

## 752. SUBMERSIBLE VEHICLE SYSTEMS DESIGN

A lecture and design course. Lectures review material pertinent to design, including a 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 credits.

## 757. COASTAL ENGINEERING AND PROCESSES

Fundamentals of water waves and their effects. Development of governing 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 credits.

## 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 lectures; 1 laboratory; 4 credits.

## 763. MICROSTRUCTURE OF SOLIDS

Basic concepts and measurements of microstructures; 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 credits.

## 766. PHYSICAL CERAMICS

Characteristics of crystalline and noncrystalline ceramic solids; defect structures; diffusion in ceramic materials; nucleation, crystal growth, and solid-state reactions; kinetics of grain growth, sintering, and vitrification. 4 credits.

## 781. MATHEMATICAL METHODS IN ENGINEERING SCIENCE I

Mathematical methods in engineering sciences are discussed, including methods for solution of discrete and continuous sys-

tems. Course includes a review of calculus, linear algebra, complex numbers, Fourier series, and differential and partial differential equations, with examples from acoustics, vibration theory, hydrodynamics, elasticity, solid mechanics, transport theory, and particle mechanics. 4 credits.

## 793 a-d and 794 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 credits.

## 795 a-d and 796 a-d. INDEPENDENT STUDY

Course numbers refer to topics in a) thermal science, b) solid mechanics, c) engineering design, and d) materials. 2–4 credits.

## 801. IRREVERSIBLE THERMODYNAMICS

Non-equilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prerequisite: Mechanical Engineering 701. 4 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 807. COMPRESSIBLE FLUID FLOW

General equations of motion for real and ideal compressible fluid flow, including boundary layer equations, methods of solution. Prerequisite: Mechanical Engineering 707 or 708. 4 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 826. THEORY OF ELASTICITY

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

## 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 credits.

## 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 credits.

## 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 credits.

## 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 credits.

## 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: Electrical Engineering 851. 4 credits.

## 860. 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 credits.

## 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 credits.

## 882. MATHEMATICAL METHODS IN ENGINEERING SCIENCE II

This course is a continuation of Mechanical Engineering 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 credits.

## 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,

# Microbiology

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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 credits.

## 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 credits.

## 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 credits.

## 895 a-d and 896 a-d. GRADUATE INDEPENDENT STUDY

Investigation of graduate level problems or areas germane to mechanical engineering. 1-4 credits.

## 899. MASTER'S THESIS

6-10 credits.

Students may also enroll in Technology (45) 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 distributions; 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 credits.

# Microbiology (70)

**Chairman:** Theodore G. Metcalf

**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.

## 701. ADVANCED MICROBIOLOGY

The growth, nutrition, and metabolism of microorganisms; consideration of cell structure and localization of function; aspects of genetic and nongenetic regulation of metabolism; study of the influences of chemical and physical factors of the environment upon microorganisms. Mr. Chesbro, Mr. Zsigray. Prerequisites: Microbiology 503, General Microbiology, and a course in general biochemistry. 2 lectures; 1 laboratory; 4 credits.

## 702. PATHOGENIC MICROBIOLOGY

The morphological, cultural, biochemical, serological and pathogenic characteristics of microorganisms causing human and animal diseases. Mr. Pistole. Prerequisite: Microbiology 503, General Microbiology. 2 lectures; 2 laboratories; 4 credits.

## 705. IMMUNOLOGY AND SEROLOGY

The defensive elements possessed by man and animals which serve to protect them from infectious microorganisms. A consideration of serum proteins, including immunoglobulins and complement, autoimmune phenomena, hypersensitivity, and immunohematology. The principles of serological techniques used in the recognition and identification of biological materials, including microorganisms. The preparation of vaccines and the production of antisera in animals. Mr. Pistole. Prerequisite: Microbiology 702. 2 lectures; 2 laboratories; 4 credits.

## 706. VIROLOGY

The animal and plant viruses, including bacteriophages and the

rickettsiae; a consideration of techniques for the propagation and recognition of animal viruses; the interactions between virus and host cell; and the application to problems of human, plant, or animal infections caused by viruses. Mr. Metcalf. Prerequisite: Microbiology 702. 1 lecture; 3 laboratories; 4 credits.

## 707. MARINE MICROBIOLOGY

Characterization of microorganisms in the sea including their taxonomy, physiology, and ecology; and sampling, enumeration, distribution, and the effects of the marine environment upon the microbial population. Mr. Jones. Prerequisite: Microbiology 503, General Microbiology, and Organic Chemistry. 2 lectures; 1 laboratory; 4 credits.

## 708. MICROBIAL BIOGEOCHEMISTRY

Geochemical processes modified or governed by biochemical processes catalyzed by microorganisms in the sea and soil; and transformations of carbon, nitrogen, oxygen, hydrogen, sulfur, phosphorus, silicon, and trace elements. Specialized aspects of geological microbiology including petroleum microbiology, natural gas production, sulfur formation, ferromanganese nodules, corrosion, and fossil microorganisms, will be considered. Mr. Jones. Prerequisites: Microbiology 503, General Microbiology, and a course in organic chemistry. 2 lectures; 1 laboratory; 4 credits.

## 795, 796. PROBLEMS OF MICROBIOLOGY

Special problems, depending upon the training and desire of the student. Elective only upon consultation. Staff. Credits to be arranged.

## 800. SYSTEMATIC MICROBIOLOGY

Procedures and methods for the classification of microorganisms; review of modern systems of classification. Staff. Prerequisite: one year of microbiology. 2 lectures; 1 laboratory; 3 credits.

## 802. MICROBIAL PHYSIOLOGY

Microbial physiology is the study of the means by which microorganisms survive. It deals with the effects of nutritional, chemical, and physical factors on microbial growth, the generation of activated metabolites during catabolism; and the use of these metabolites for the synthesis of macromolecules, the nongenetic mechanisms directing and regulating cellular metabolism; the biochemical cytology of the microbial cell; and with evolutionary and ecological relationships among microbial species. Mr. Chesbro. Prerequisite: a course in general biochemistry (may *not* be taken concurrently) and Microbiology

503, General Microbiology. 2 lectures; 2 laboratories; 4 credits.

## 803. MICROBIAL CYTOLOGY

The fine structure of bacteria and related organisms. (Prokaryotic Protists). Application of current techniques for the demonstration and isolation of external appendages, cell walls, cytoplasmic membrane, protoplasts, inclusions, and chromatin bodies. Prerequisite: Microbiology 701. 2 lectures; 1 laboratory; 4 credits.

## 804. MICROBIAL GENETICS

An introduction to genetic principles applicable to microorganisms; fine structure of genetic material, mutation, selection, recombination, transformation, transduction, and extra chromosomal inheritance. Mr. Zsigray. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

## 851. CELL CULTURE

A consideration of the theory and principles fundamental to the culture 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. Biggs Haugstad. Prerequisite: Microbiology 503, General Microbiology; permission of instructor. 2 lectures; laboratory hours arranged; 4 credits. (Also offered as Animal Science 851.)

## 897-898. MICROBIOLOGY SEMINAR

Reports and discussions on microbiological literature and recent developments in microbiology. Staff. Prerequisite: permission of instructor. 1 credit.

## 899. MASTER'S THESIS

6-10 credits.

## 999. DOCTORAL RESEARCH

## Music (71) (72)

Chairman: Paul Verrette

PROFESSORS: Donald Steele, John Wicks

ASSOCIATE PROFESSORS: Alan Grishman, Cleveland Howard, Keith Polk, Mary Rasmussen, John Rogers, John Whitlock

ASSISTANT PROFESSORS: Mark DeVoto, Stanley Hettlinger, Niel Sir, Paul Verrette, Henry Wing, Jr.

# Music

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The Department of Music offers programs leading to the degrees of Master of Art 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 from the 700 series in music or the 600, 700, and 800 series in other departments with the permission of his 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 his 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 in music 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 6 credits in the Department of Education from courses such as the following: Education 820, 855, 858, 865, 883, 886, 892, 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 his entrance into the graduate program. Students not meeting standards in the placement examinations will be required to make up their deficiencies.

## Music (71)

### 701. MUSIC OF THE MEDIEVAL PERIOD

The nature of the beginnings of polyphony. The preeminent influence of the church in the thirteenth century and the rising secular movement in the fourteenth. Music as a dominant force in the political and social life of the Middle Ages. Mr. Polk. 4 credits.

### 703. MUSIC OF THE RENAISSANCE

A study of the works of the composers of the fifteenth and sixteenth centuries from Dunstable to Palestrina. Mr. Polk, Mr. Wicks. 4 credits.

### 705. MUSIC OF THE BAROQUE

A study of the music of Europe from de Rore to Bach. Mr. Wicks. 4 credits.

### 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. The class will hear representative works in the areas of symphony, concerto, and opera. Mr. Grishman. 4 credits.

### 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. Mr. Steele. 4 credits.

### 711. MUSIC OF THE TWENTIETH CENTURY

A study of contemporary music, including its literature, its trends, and an analysis of techniques, styles, forms, and expression. Mr. DeVoto. 4 credits.

## 721. THE LIFE AND WORKS OF BEETHOVEN

The piano sonatas, the concerti, symphonies, and string quartets. Lectures, analysis, reports, required readings, and listening. Mr. Steele. 4 credits.

## 732. THE ART SONG

A study of the history and literature of the solo song with piano accompaniment. The course is intended to provide a broad background in the various national styles of the 19th and 20th centuries as well as a deeper study of the central core of the art song—the German *lied*. Mr. Wing. 4 credits.

## 733. SURVEY OF OPERA

An investigation of representative masterpieces of this art form through listening, reading, and discussion. Mr. Wing. 4 credits.

## 735-736. SURVEY OF PIANOFORTE LITERATURE

The history and development of 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 contemporary writers. Mr. Steele. 4 credits.

## 754 (754). COLLEGIUM MUSICUM

A flexible group of instrumentalists and singers organized to perform small ensemble music from all periods, with emphasis on Renaissance and Baroque music. Ms. Rasmussen. Prerequisite: permission of instructor. 1 credit.

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

An investigation of music for vocal, vocal-instrumental, and instrumental ensemble, circa 1100 to 1450, and its realization in performance, especially with regard to rhythm, *musica ficta*, notation, melodic ornamentation, improved polyphony, and the clear projection of a polyphonic texture. Course work includes an 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. Mr. Polk. 2 or 4 credits.

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

An approach to the problems of musical performance circa 1450 to 1600, via the small vocal, vocal-instrumental, and instrumental ensemble, with special reference to rhythm and tempo, *musica ficta*, text underlay, articulation, diminution, tablature notation, and effective distribution of voices and instruments. Course work includes a survey of performance

manuals, iconographical sources, and current research; development of editing technique through the preparation of transcriptions; and an opportunity to perform on representative musical instruments of the period, notably the organ, harpsichord, lute, viols, recorders, cornetto, and trombones. Mr. Polk, Ms. Rasmussen, Mr. Wicks. 2 to 4 credits.

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

A study of 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. Ms. Rasmussen, Mr. Wicks. 2 to 4 credits.

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

An intensive examination of musical styles, circa 1760 to 1815, through the performance of keyboard music and instrumental chamber music, emphasizing the relationship between structure and interpretation, late eighteenth-century conventions of ornamentation and articulation, a survey of tutors and relevant theoretical writings, and a critique of currently published editions and editing techniques. Mr. Grishman, Ms. Rasmussen. 2 to 4 credits.

## 759 (759). PERFORMANCE STUDIES IN NINETEENTH-CENTURY MUSIC

The art of performing and coaching *Lieder*, piano music, and instrumental chamber music from Schubert through Debussy, with special consideration given to effective ensemble, traditions of interpretation, and the influence of structure on performance. Mr. Steele, Mr. Grishman. 2 to 4 credits.

## 760 (760). PERFORMANCE STUDIES IN TWENTIETH-CENTURY MUSIC

Performance of representative twentieth-century compositions for small instrumental or vocal-instrumental ensemble, 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. Mr. Polk, Mr. Rogers, Mr. Verrette. 2-4 credits.

# Music

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## 771-772. COUNTERPOINT

First semester: polyphony in two to four voices, based on the linear, harmonic, and rhythmic techniques of sixteenth-century vocal music. Work in species and imitative forms as exemplified by Palestrina. Second semester: tonal counterpoint, based on eighteenth-century style. Various exercises in two to four voices, referring to keyboard and instrumental examples of Bach and Handel. Mr. Rogers. Prerequisite: Music 571-572, Counterpoint, or permission of instructor. 2 credits.

## 773. CANON AND FUGUE

Continuation of studies in tonal counterpoint. Construction of canons and 2-, 3-, and 4-voice fugues, based on the keyboard and instrumental style of Bach. Mr. Sir. Prerequisite: Music 771-772 or permission of instructor. 2 credits.

## 775-776. COMPOSITION

Consideration of simple phrase structures, binary and ternary forms as exemplified in classic sonata movements, theme and variations, and textsettings as basic models for the uniting of specific composition projects. Mr. Sir. Prerequisite: permission of instructor. 2 credits.

## 777-778. ADVANCED COMPOSITION

Composition projects of the student, unlimited in scope and nature and reflecting the student's compositional interests. Guidance and advice of the instructor as appropriate to each individual project. Prerequisite: permission of instructor. 4 credits.

## 779. ORCHESTRATION

The characteristics of band and orchestral instruments, both individually and in small (homogeneous) and large (mixed) groupings. Students will be expected to study appropriate scores, to write arrangements utilizing these various groupings, and to have these arrangements performed if at all possible. Some aspects of vocal writing will also be covered. Mr. DeVoto, Mr. Rogers. Prerequisite: permission of instructor. 4 credits.

## 781. FORM AND ANALYSIS

A consideration of various formal and textural elements as concepts and within the context of musical examples. Thorough analysis of smaller and larger masterworks from the standpoint of harmony, counterpoint, structural line, and formal articulation. Mr. DeVoto. Prerequisite: permission of instructor. 4 credits.

## 785. ELECTRONIC SOUND SYNTHESIS

A practical course in the creation of sounds by electronic and computer synthesis. The course will be divided into three sections. Part I will deal with "traditional" or "analog" electronic sound synthesis, with students having the opportunity to work with the Buchla Synthesizer in the UNH Electronic Music Studio. Part II will deal with the following areas of computer sound synthesis: (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 the IBM 360/50 Computer and its associated 12-bit digital/analog converter. Part III will be devoted to supervised independent study in one or both of the above areas. Mr. Rogers. Prerequisite: permission of instructor. 4 credits.

## 795. SPECIAL STUDIES IN MUSIC LITERATURE

Presuming a sound musical background, this course allows the student to investigate independently and in depth any of a vast range of subjects. Barring duplication of material, this course may be repeated for credit. Prerequisite: permission of instructor. 1-4 credits.

## 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 chairman 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 his major adviser. Music staff. 1-2 credits.

- 841 (841). GRADUATE VOICE
- 842 (842). GRADUATE PIANO
- 843 (843). GRADUATE HARPSICHORD
- 844 (844). GRADUATE ORGAN
- 845 (845). GRADUATE VIOLIN, VIOLA
- 846 (846). GRADUATE VIOLINCELLO, 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. Ms. Rasmussen, Mr. Wicks. 3 credits.

**856. READINGS IN MUSIC HISTORY: ANTIQUITY TO 1600**

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. Polk, Mr. Wicks. 3 credits.

**857. READINGS IN MUSIC HISTORY: 1600-1820**

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. Polk, Mr. Wicks. 3 credits.

**858. READINGS IN MUSIC HISTORY: 1820 TO THE PRESENT**

An opportunity to read and study in detail a restricted number of monographs and editions. Mr. DeVoto, Mr. Grishman. 3 credits.

**891-892. RESEARCH SEMINAR**

Guidance in individual research projects. Prerequisite: permission of instructor. Variable credit.

**893. THEORY SEMINAR**

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

**894. THEORY SEMINAR**

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

**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 credits.

**Music Education (72)**

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

A lecture-workshop course concerning problems in the organization and performance of high school, college, and community choruses. Emphasis is placed on techniques of choral conducting and rehearsal, repertory, and materials. Mr. Howard. 2 credits.

**743. MATERIALS AND METHODS IN PIANO MUSIC**

A course designed to give 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. Ms. Edwards. 2 credits.

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

Class and individual instruction on stringed instruments; students are expected to practice four hours per week as a basic course requirement. A high level of instrumental proficiency results from intensive training on the violin, viola, cello, and double bass, enabling participants to perform in string ensembles. The course will explore classroom procedures, the establishment of string programs, and the evaluation of available methods and materials. Mr. Grishman. 2 credits.

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

Basic fundamentals of performance in woodwind instruments, techniques of class instruction, associated acoustical problems, and study of woodwind literature. Emphasis in the first semester will be on clarinet, flute, and saxophone. The double reed instruments will be emphasized in the second semester. Mr. Hettinger. 2 credits.

**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, in conjunction with a survey of the 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. Ms. Rasmussen. 2 credits.

**751. TECHNIQUES AND METHODS IN PERCUSSION INSTRUMENTS**

The basic skills necessary for performance on snare drum, tympani, mallet instruments, and the other percussion instruments used in bands and orchestras. Materials and methods of instruction are included. Mr. Whitlock. 2 credits.

**785. MUSIC FOR THE ELEMENTARY CLASSROOM TEACHER**

For the non-specialist interested in utilizing music in the classroom. The correlation and integration of music in the school curriculum, and the basic skills and techniques necessary. Mr. Whitlock. 4 credits.

# Occupational Education

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## 787. PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL MUSIC.

Aims, scope, and organization of materials and activities in the elementary schools. Modern trends in educational philosophy, development of the child's voice, and demonstration of materials and methods for the various grades. Observation and teaching in schools. Mr. Howard, Mr. Whitlock. Seminar and laboratory. 2 credits.

## 791. PROBLEMS IN THE TEACHING OF SECONDARY SCHOOL MUSIC

The application of educational principles to the teaching and learning of music and the organization of the music curriculum on the junior and senior high school levels. The adolescent voice, the classification of voices, the selection of vocal and instrumental materials, and the building of unified concert programs. Problems of administration, management, and the relationship of the teacher to school and community. Observation of music programs in secondary schools. Mr. Howard, Mr. Whitlock. 4 credits.

## 795. SPECIAL STUDIES IN MUSIC EDUCATION

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

## 796. ORGANIZATION AND ADMINISTRATION OF SCHOOL MUSIC GROUPS

Problems of school orchestra, band, glee club, chorus, and small-ensemble organizations and administration, such as objectives, motivation, schedule, discipline, equipment, programs, finances, rehearsal techniques, contests and festivals, materials, personnel selection, and grades. Mr. Howard, Mr. Whitlock. 4 credits.

## 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. Mr. Grishman, Mr. Hettinger. 3 credits.

## 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. Mr. Howard. 3 credits.

## 895. SPECIAL PROJECTS IN MUSIC EDUCATION

Independent study, investigation, or research in Music Education. Creative projects may be included. Mr. Howard, Mr. Whitlock. Prerequisite: permission of instructor. 1-4 credits.

## Occupational Education (23)

**Chairman:** William H. Annis

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

**ASSOCIATE PROFESSOR:** Jesse James

**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 and County Co-operative Extension Service personnel, and others in adult education. This degree has been expanded to utilize the faculties and facilities of UNH, Keene State College, and Plymouth State College. Students may register at any of these campuses for the degree. Faculty from at least two different campuses must be represented on the student's graduate committee. Applicants must submit scores achieved on either the Graduate Record Examination aptitude section or Millers Analogies Test. All students are required to take a qualifying examination prior to completing 12 semester hours of credits. This experience will be used to identify areas for further study consistent with the student's career plans and occupational goals.

All students are required to complete a minimum of 30 credit hours of course work which must include Occupational Education 785 and 786. Students may elect to write a thesis which may receive 6-10 credits. All students must pass a comprehensive examination for completion of the program.

The program is coordinated by a committee composed of Robert E. Wenig, Keene; Regis Horace, Plymouth; William H. Annis, UNH; Richard Barker, State Department of Education; and William H. Drew, acting dean, UNH Graduate School.

## 750. SHOP ORGANIZATION AND CONTROL METHODS

Shop organization and control methods to promote efficiency in the control of instruction, equipment, and materials. 4 credits.



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

The techniques of adult education in terms of: identifying needs, program planning, methods of teaching, supervision, and evaluation. Prerequisite: Occupational Education 550, Principles of Occupational Education, or permission of instructor. 4 credits.

**784. THE COMMUNITY-JUNIOR AND VOCATIONAL-TECHNICAL COLLEGES**

A study of the rise and development of the community-junior college and the two-year vocational-technical college in American education; their history, potential, philosophy, and functions. 4 credits.

**785. ADVANCED METHODS AND MATERIALS OF INSTRUCTION**

The organization of instruction to meet individual and student needs; development and use of resource files and instructional materials. Evaluation in teaching vocational-technical education. Open to teachers of vocational-technical education, and others by permission of instructor. 4 credits.

**786. CONCEPTS OF VOCATIONAL-TECHNICAL EDUCATION**

The development of vocational-technical education in the United States, with emphasis on the socio-economic influences responsible for its establishment. The federal and state requirements for programs in the secondary and post-secondary schools will be discussed. Coordination of programs with general education and other vocational fields. 4 credits.

**791. PLANNING FOR TEACHING**

The 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, and program evaluation. Prerequisite: permission of instructor. 4 credits.

**796. INVESTIGATIONS IN OCCUPATIONAL EDUCATION: (1) SECONDARY EDUCATION, (2) POST SECONDARY EDUCATION, (3) ADULT EDUCATION, (4) EXTENSION EDUCATION, (5) EXEMPLARY PROGRAMS, (6) COOPERATIVE EDUCATION PROGRAMS, AND (7) DISADVANTAGED AND HANDICAPPED EDUCATION PROGRAMS**

An opportunity is provided for a student to study a special problem in one of the areas listed. Elective after consultation with the instructor. Hours to be arranged. 2 to 4 credits. May be repeated.

**798. OCCUPATIONAL EDUCATION SEMINAR**

Study of research and development in Occupational Education. Includes student and faculty presentations and discussion. Required of Occupational Education majors. 0 credit.

**802. METHODS OF TEACHING POWER AND MACHINERY IN OCCUPATIONAL EDUCATION**

Teaching 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 credits.

**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. 3 credits.

**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 credits.

**806. PREPARATION AND USE OF VISUAL AIDS FOR OCCUPATIONAL EDUCATION**

The purpose of visual aids and the kinds best adapted to use in the program, together with their preparation and use. 4 credits.

**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 credits.

**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 credits.

## 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 credits. May be repeated up to 8 credits.

### 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 credits.

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

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

### 899. MASTER OF OCCUPATIONAL EDUCATION THESIS

6-10 credits

## Physical Education (40)

**Chairman:** Robert Kertzer

**ASSOCIATE PROFESSORS:** Katherine Amsden, Gavin H. Carter, Phyllis A. Hoff, Robert Kertzer, Robert E. Wear, Walter E. Weiland

**ASSISTANT PROFESSOR:** Jean Morrison

**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 to graduate study is granted only after evaluation and approval by the Graduate School and the department. This evaluation is based on the applicant's undergraduate preparation, academic record, Graduate Record Examination scores (student must submit GRE scores for the aptitude test), plus letters of recommendation. An applicant must be an above-average student and have been graduated from an accredited college or university with a minimum of 24 credits of 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 minimum of 30 approved graduate credits including a thesis (24 graduate course credits plus 6 thesis credits) are required. Physical Education 801 and Resource Economics 701 or a comparable statistics course (upon approval of graduate adviser) are required of all degree candidates. At least 6 graduate credits, in addition to statistics, must be taken outside of the Department of Physical Education. At least 11 graduate credits, in addition to Physical Education 801, must be taken in the Department of Physical Education. Each student is expected to demonstrate competency in formulating and developing a thesis problem which must be approved by his adviser and thesis committee. An oral defense of the thesis is required.

Several courses are available in each of the following areas: 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 special interests and abilities of the student. With the help of his faculty adviser, the student's program will be individually planned.

### 720. INTERPRETATION AND ASSESSMENT OF PHYSICAL FITNESS

This course will focus on physical fitness as it applies to the well being of all people, young and old. Stress will be placed on practical programs of conditioning and fitness, as a unique contribution of physical education to the general program of education in the school. Topics covered will include the contribution of physical fitness to total personal fitness, the components of physical fitness and conditioning, the place of physical fitness activities in the school physical education program, current tests of fitness, and the planning and implementation of fitness programs for the public school curriculum. Further emphasis will be given to practical fitness conditioning and rehabilitation of individuals of all ages, particularly those in college and adult programs. Prerequisite: permission of instructor. 4 credits.

### 730. CURRICULUM PLANNING IN PHYSICAL EDUCATION

Study of the criteria and factors involved in the planning and construction of school physical education programs. 4 credits.

### 775. PERCEPTUAL MOTOR LEARNING

The variables which affect the learning and performance of

skilled activity, including ability and motivational characteristics of the learner, and the processes which enhance skill acquisition. Prerequisite: Psychology 401, Introduction to Psychology. 3 lectures; 1 laboratory; 4 credits.

## 780. PSYCHOLOGICAL FACTORS IN SPORT

An investigation of the factors related to outstanding athletic achievement, the psychological variables involved in competition, and the actions and interactions of sport, spectator, and athlete. Prerequisite: Psychology 401, Introduction to Psychology, or Physical Education 775, and permission of instructor. 3 lectures; 4 credits.

## 791. HISTORY OF PHYSICAL EDUCATION

A comprehensive history of physical education extending from ancient Egypt to modern times. Particular emphasis to be placed on the influences of Greece, Rome, the Renaissance, and Reformation periods, and modern European nationalism. A critical analysis of sequential events and the beliefs of leaders in the development of systems of physical education. 4 credits.

## (801). RESEARCH METHODS IN PHYSICAL EDUCATION

Designed to acquaint the student with the scope and techniques of research in physical education and to establish the relationship of physical education research to research in education and the social and biological sciences. Topics covered will include the Computation Center resources, methods of research, hypothesis formulation, and the format of the research report. Students will have the opportunity to read current research in physical education. Prerequisite: Physical Education 668, Measurement Procedures in Physical Education, or equivalent. 3 credits.

## 820. CONCEPTS OF MOVEMENT EXPERIENCE

A philosophical study of the experience of movement from the standpoint of the participant and of the observer in a range of sports, dance, and everyday movements. 3 credits.

## 831. CONDITIONING FOR MAXIMUM PERFORMANCE

Examination of the anatomical and physiological factors related to maximum physical performance. Evaluation of present programs of training. Prerequisite: Physical Education 620, Physiology of Exercise, or equivalent. 3 credits.

## 841. SOCIAL DIMENSIONS OF SPORT

The study of sport as described from a social-cultural, action-system frame of reference. Study and discussion will begin with the play element in culture and the origin of sport. The problem of sport will be discussed on the level of cultural values

and their related social structure to show how sport is bound to society and structured by general culture. Prerequisite: Sociology 400, Introductory Sociology, or equivalent. 3 credits.

## 850. SEMINAR IN MOTOR LEARNING

Development of a taxonomy of motor skills, discussion of current issues in motor-learning research, and analysis and evaluation of models of skill learning. 3 credits.

## 895, 896. ADVANCED STUDIES

The sections of this course provide for advanced work either on a group-seminar or an independent-study basis. Course emphasis will be directed on investigation, presentation, and discussion of recent studies of special concern to physical education. The exact topics for study will vary from semester to semester; they will be selected to meet the needs and interests of the students. 2-6 credits.

## 899. MASTER'S THESIS

6 credits.

## Physics (53)

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

**PROFESSORS:** Edward L. Chupp, Robert E. Houston, Jr., Richard L. Kaufmann, John A. Lockwood, Robert H. Lambert, Lyman Mower, John E. Mulhern, Jr., William R. Webber

**ASSOCIATE PROFESSORS:** Roger L. Arnoldy, L. Christian Balling, David G. Clark, Harvey K. Shepard, Robert E. Simpson

**ASSISTANT PROFESSORS:** John F. Dawson, Edmond C. Roelof, Richard N. St. Onge, 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 graduate students in Physics, except M.S.T. degree students, are required to take a preliminary, comprehensive, written qualifying exam at the beginning of the fall semester of their second year. This exam will emphasize quantum mechanics, electricity and magnetism, and classical mechanics at the undergraduate and first-

# Physics

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year graduate level. It will be given on two days, each part being approximately four hours in duration.

On the basis of their performance on this examination students may qualify at the M.S. or Ph.D. levels. 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 11) or who hold a secondary school teacher certification in physics or in general physical science. The course 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 chairman or the 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. All M.S. students are required to take the qualifying examination. Candidates may select one of the following two options:

- a) Complete 30 semester hours of courses chosen in consultation with the graduate adviser.
- b) 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, he 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 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, 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.) 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:

- a) Satisfactory performance on the Educational Testing Service foreign language examination.
- b) Satisfactory performance on the reading examination administered by the department.
- c) After two attempts at either a) or b), the requirement may be satisfied only by the completion of a one-year course in the language.

### 607. PHYSICAL OPTICS

The electromagnetic theory of light, interference, diffraction, polarization, related phenomena, and nonlinear optics. Prerequisite: Mathematics 527, Differential Equations. 4 credits.

### 701. INTRODUCTORY QUANTUM MECHANICS

An introduction to quantum mechanics with applications to atomic and molecular spectra. Prerequisite: permission of instructor. 4 credits.

### 702. ATOMIC AND NUCLEAR PHYSICS

Natural radioactivity, nuclear reactions, nuclear scattering, models of the nucleus, high energy nuclear physics, cosmic rays. Prerequisite: Physics 701. 4 credits.

### 703-704. ELECTRICITY AND MAGNETISM I AND II

Foundation of electromagnetic theory, including electrostatics, dielectric theory, electromagnetism, magnetic proper-

ties of matter, alternating current. Maxwell's field theory, and an introduction to electrodynamics. Prerequisite: permission of instructor. 4 credits.

## 831-832. MATHEMATICAL PHYSICS

Complex variables, differential equations, asymptotic methods, integral transforms, special functions, linear vector spaces and matrices, Green's functions, integral equations, variational methods, numerical methods, and tensor analysis. 3 credits.

## 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 Physics 605. 3 credits.

## 834. EXPERIMENTAL PHYSICS II

Modern research techniques. Prerequisite: Physics 833. 1-3 credits.

## 835. STATISTICAL PHYSICS I

A review of thermodynamics and kinetic theory, followed by an introduction to statistical thermodynamics. Prerequisite: Physics 831 or permission of instructor. 3 credits.

## 836. STATISTICAL PHYSICS II

Basic formulation and application of statistical mechanics to physical problems. (Offered on request.) Prerequisite: Physics 844. 3 credits.

## 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 credits.

## 841-842. ELECTROMAGNETIC THEORY

The formulation and detailed application of electromagnetic theory to physical problems. Prerequisite: permission of instructor. 3 credits.

## 843-844. QUANTUM MECHANICS

Wave mechanical and Dirac formulations of non-relativistic quantum mechanics. Prerequisite: permission of instructor. 3 credits.

## 850. PLASMA PHYSICS I

Topics to be discussed will be selected from the following: magnetohydrodynamics and plasma flow, waves, shock waves and discontinuities, instabilities, and adiabatic motion of charged particles. 3 credits.

## 852. PLASMA PHYSICS II

Topics to be discussed will be selected from the following: kinetic theory of plasmas, plasma waver, instabilities, and non-linear plasma phenomena. Offered on request. Prerequisite: Physics 835. 3 credits.

## 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. Prerequisites: Physics 839 and 844. 3 credits. 861 offered alternate years; 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: Physics 844. 3 credits. 863 offered alternate years; 864 offered on request.

## 865-866. SOLID STATE PHYSICS

Development of quantum mechanical theory of solids, transport phenomena, etc. Prerequisite: Physics 843 and 835. 3 credits. Offered alternate years.

## 887. COSMIC PHYSICS I

Introduction to particle motion in the geomagnetic and interplanetary field, study of the energy-loss processes of energetic particles and their interaction with the earth's atmosphere; the earth's ionosphere and exosphere; and interplanetary physics. 3 credits.

## 888. COSMIC PHYSICS II

General transport equations for energetic particle motion in the galaxy; structure and measurement of the interstellar medium; the origin of electrons, x-rays and gamma rays; and the introduction to cosmological problems. 3 credits.

## 889-890. SPACE PHYSICS SEMINAR

Lectures and discussions of current research in the physics of fields and particles in space. 1-3 credits.

## Plant Science

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### 891, 892. PROBLEMS IN THEORETICAL PHYSICS

May be taken more than once. Offered on request. 3 credits.

### 893, 894. PROBLEMS IN EXPERIMENTAL PHYSICS

May be taken more than once. Offered on request. 3 credits.

### 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 credits.

### 897-898. COLLOQUIUM

Required of all graduate students. Topics to be selected. No credit.

### 899. MASTER'S THESIS

6 credits.

### 999. DOCTORAL RESEARCH

## Plant Science (24)

**Chairman:** Lincoln C. Peirce

**PROFESSORS:** Gerald M. Dunn, C.A. Langer, Lincoln C. Peirce, Owen M. Rogers, Douglas G. Routley

**ASSOCIATE PROFESSORS:** George O. Estes, J. Brent Loy, Jerry Warren, Otho S. Wells

**ASSISTANT PROFESSORS:** Yun-Tzu Kiang, David W. Koch, James E. Pollard

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 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 his or her 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

Nutrient requirements of plants, ion uptake, translocation, and accumulation mechanisms; role of elements in metabolic processes. Genetic and environmental factors governing nutrient absorption and composition of plants. Mineral element and soil-plant relationships governing nutrient availability; growth, yield, and crop quality as influenced by nutrient status; characteristics and formulation of commercial fertilizers. Laboratory emphasis on analytical procedures and instrumentation for soil and plant tissue analysis. Mr. Estes. Prerequisite: Plant Physiology, Organic Chemistry, Soils. 3 lectures; 1 laboratory; 4 credits. Alternate years; offered spring 1976.

### 762. PLANT METABOLISM

The function, occurrence, synthesis, and degradation of plant constituents. Emphasis is placed on respiration and photosynthesis and the metabolism of nitrogenous and aromatic compounds. Biochemical mechanisms such as those involved in seed dormancy, fruit ripening, and disease resistance are discussed in relation to their roles in plant survival. Mr. Routley. Prerequisite: Biochemistry 751 or equivalent. 2 or 4 credits.

### 769. PLANT GROWTH REGULATORS

Study of hormones and plant growth substances; relationships to differentiation and development of plant tissues. Mr. Routley. Prerequisite: Plant Physiology, Biochemistry. 2 lectures; 2 laboratories; 4 credits. Alternate years; offered fall 1975.

### 863. PLANT GROWTH AND DEVELOPMENT

The biochemistry and physiology of growth and development processes are studied through current research papers illustrating recent advances in plant physiology. Topics include cell elongation, cell wall metabolism, absorption, stress physiology, dormancy, water relations, translocation, differential growth,

growth regulators, and senescence. Mr. Pollard. Prerequisite: Plant Physiology and Biochemistry. 3 lectures; 1 laboratory; 2 or 4 credits.

## Advanced Genetics (See Genetics Program)

### 705. POPULATION GENETICS

The population growth and regulation; the distribution of genes in populations; factors affecting gene frequency such as mode of inheritance, mating systems, mutation, migration, genetic drift, selection and linkage disequilibrium; genetic load, cost of natural selection and ecological genetics. Mr. Kiang. Prerequisite: Zoology 604, Principles of Genetics; and Forest Resources 528, Applied Statistics I; or equivalents; or permission of instructor. 4 lectures; 4 credits.

### 732. DEVELOPMENTAL GENETICS

Fundamental concepts concerning gene action in relation to development, with emphasis on plant organisms. Topics will include isozymes and differentiation, chromosomal proteins and gene regulation, temporal specificity of gene action, nuclear-cytoplasmic interactions, chemical gradients and gene activation, and gene control of differentiation. Prerequisite: Introductory Genetics and Introductory Physiology. Mr. Loy. 3 lectures; 1 laboratory; 4 credits. Alternate years; offered spring 1975.

### 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 adaptation in animals, plants, and man; evolution of communities; molecular evolution and rates of evolution. Mr. Kiang. Prerequisite: Zoology 604, Principles of Genetics; or equivalent; or permission of instructor. 4 lectures; 4 credits. Alternate years; offered spring 1976.

### 773. METHODS AND THEORY OF PLANT BREEDING

Theory and use of plant breeding systems with emphasis on improving quantitative plant improvement. Mr. Peirce. Prerequisite: Genetics, Statistics; or permission of instructor. 3 lectures; 3 credits. Alternate years; offered fall 1974.

### 851. PLANT GENETICS

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation, and genetics of disease resistance. Mr. Dunn. Prerequisite: Genetics. 3 credits. Alternate years; offered fall 1975.

### 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 lectures; 1 laboratory; 3 credits. Alternate years; offered fall 1974.

## General Offerings and Independent Studies

### 776. RADIOISOTOPE TECHNIQUES FOR LIFE SCIENCES

Fundamental concepts and laboratory practice on the application of radioisotopes to biological systems. Techniques include detection and measurement principles, liquid scintillation spectrometry and autoradiography, gamma-ray spectrometry, radiochromatogram scanning, and tissue distribution of radioisotopes in whole animals. Prerequisite: General Inorganic Chemistry and General Physics. Mr. Estes. 2 lectures; 2 laboratories; 4 credits.

### 795, 796. ADVANCED TOPICS IN PLANT SCIENCE

A flexible course structure permitting independent study or group discussion of advanced technical or scientific topics. Students should consult with appropriate course coordinator before registering. 2-4 credits.

R-1 Physiology—Mssrs. Estes, Koch, Pollard, Routley  
R-2 Genetics—Mssrs. Dunn, Kiang, Loy, Peirce, Rogers  
R-3 Plant Utilization—Staff

### 877 (877). SUPERVISED TEACHING FOR GRADUATE STUDENTS

A course to introduce graduate students to techniques of planning and presenting classroom and laboratory material. The student will be responsible for preparing and presenting a total of four contact hours of lecture and/or laboratory material per semester in the specific course in which the student is participating. Biweekly seminars will serve as a forum for discussion of teaching techniques and problems. Students are encouraged to use voice and video recorders and other diagnostic tools and services available for correction of specific problems. One credit or its equivalent required of each Plant Science master's and Ph.D. candidate. Enrollment limited to Plant Science graduate students only. Prerequisite: permission of instructor. 1 credit. NLG.

### 895-896. RESEARCH IN PLANT SCIENCE

Advanced investigations in a research subject, exclusive of thesis. Staff. 1-4 credits.

## Political Science

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### 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 credit.

### 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 credits.

### 999. DOCTOR OF PHILOSOPHY THESIS

Dissertation reflecting independent research in a phase of Plant Science is required. Credit received upon completion.

## Political Science (75)

**Chairman:** Bernard K. Gordon

**PROFESSORS:** Robert B. Dishman, Bernard K. Gordon, George K. Romoser

**ASSOCIATE PROFESSORS:** John R. Kayser, David L. Larson, Lawrence W. O'Connell, John Woodruff, 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 in 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 he follows without credit a program of study approved by the chairman. 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 chairman.

An essential requirement is that each candidate must arrange his program so that it includes at least one seminar (Political Science 897, 898) in each of three fields of the discipline emphasized by the department (Political Thought; American Politics; Comparative Politics; and International Politics). The remaining courses may be chosen according to the candidate's interests and needs, and two may be taken in a related field outside the department. Where a candidate lacks proficiency in tools of quantitative analysis or a foreign language essential to his program of study and research, he will be required to attain and demonstrate to his 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.

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, and sociology.

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.



Courses which have an asterisk (\*) preceding the number are often alternate-year offerings. Consult the department for schedule of courses offered in a particular semester.

## Political Thought

### 700./800. POLITICAL THOUGHT AND CULTURE

The 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 credits.

### 701./801. THE SCIENTIFIC STUDY OF POLITICS: ITS PHILOSOPHICAL DEVELOPMENT

An analysis of scientific political science, considering formulations and criticisms of this approach. The course begins with Aristotle and reviews the development of modern scientific method from Bacon to the present. 4 credits.

### \*702./802. IDEOLOGIES AND DISSENT IN AMERICA AND THE WEST

Movements of commitment, dissent, and protest since the late 19th century, particularly attacks upon liberal theory and practice in America and Europe. 4 credits.

### 797./897, 798./898. SECTION (1): SEMINAR IN POLITICAL THOUGHT

4 credits.

## 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 credits.

## American Politics

### 730./830. ADMINISTRATIVE PROCESS

The administrative and bureaucratic process in public life. Principal concepts of administration and the relationship of group behavior and policy development to the administrative process. 4 credits.

### 731./831. URBAN AND METROPOLITAN POLITICS

Planning and management of the urban community. Attention to intergovernmental relations, administrative functions, and general urban problems. 4 credits.

### 732./832. PSYCHOLOGY OF POLITICAL BEHAVIOR

Cultural, social, economic, and emotional forces molding the citizen's political activity. 4 credits.

### 733./833. INTERGOVERNMENT RELATIONS AND FEDERALISM

Interrelationship of national, state, and local governments in the context of the American federal system. Patterns of regionalism, interstate cooperation, and conflict, and the evolution of federal relations. 4 credits.

### 735./835. AMERICAN PLURALISM

Analysis and critique of theories of American pluralism. Attention to the role of private power in American politics and alternative elitist models of decision-making. 4 credits.

### 797./897, 798./898. SECTION (2) SEMINAR IN AMERICAN POLITICS

4 credits.

### 797./897, 798./898. SECTION (6): SEMINAR IN PUBLIC ADMINISTRATION

Advanced treatment, including individual research and internship opportunities in problems of administration. 4 credits.

## Comparative Politics (A. Area Studies)

### 750./850. POLITICS IN WEST EUROPE

Examination of the politics of major continental powers. 4 credits.

### 751./851. MAJOR COMMONWEALTH STATES: BRITAIN, CANADA, AUSTRALIA

Comparison and analysis of major governments influenced by the British parliamentary system, but with special emphasis on the nature of federal systems and ethnic diversity, as illustrated, for example, by French Canada. 4 credits.

### 752./852. POLITICS IN THE USSR AND EAST EUROPE

Comparative analysis of the background, structure, and underlying issues of the political systems of the Soviet Union and selected East European states. Includes examination of ideological bases and political history as well as contemporary trends. 4 credits.

### 753./853. MAJOR GOVERNMENTS OF EAST ASIA: CHINA AND JAPAN

The course will cover the political development of China and Japan, with attention to the historical context and to related economic, social, and cultural variables. Where appropriate

# Political Science

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the two countries will be considered in comparative perspectives, and their relations with each other and with the United States will be considered as factors in their internal affairs. 4 credits.

**754./854. GOVERNMENT AND POLITICS IN THE MIDDLE EAST**  
4 credits.

**797./897, 798./898. SECTION (3): SEMINAR IN COMPARATIVE POLITICS OF NATIONS**  
Advanced treatment of the politics of a nation or region (e.g., France, China, Germany, USSR, Southeast Asia). 4 credits.

## Comparative Politics (B. Problems in Comparative Politics and Development)

**757./857. POLITICAL DEVELOPMENT AND POLITICAL DECAY**  
4 credits.

**758./858. COMPARATIVE JUDICIAL PROCESSES**  
Comparative court systems and their relationships to: political life; political, social, and structural influence on judicial behavior; law; and human behavior. 4 credits.

**\*759./859. COMPARATIVE LEGISLATIVE BEHAVIOR**  
Role, organization, operation, and conduct of legislatures in various national political systems. 4 credits.

**\*760./860. COMPARATIVE COMMUNIST SYSTEMS**  
Use of comparative methods in analysis of selected aspects of Communist systems. Emphasis on interest groupings, elites, and decision-making. Attention to political behavior within Communist international organizations and to intraparty distinctions between ruling and non-ruling Communist parties. 4 credits.

**761./861. POLITICAL SOCIOLOGY**  
The impact of social structure and change upon political behavior, including elite/mass relationships, integration, and instability. Attention to major empirical findings and theoretical contributions, from Marx and Weber to the present. 4 credits.

**797./897, 798./898. SECTION (4): SEMINAR IN COMPARATIVE POLITICS**  
Advanced treatment of theoretical problems and aspects of comparative politics, normally in the fields of administration, foreign policy, political parties, and governmental institutions. 4 credits.

## International Politics

**775./875. THEORIES OF INTERNATIONAL POLITICS AND INTEGRATION**

Examination of general explanations for the behavior of nations and of the theory and practice of supranational integration. The development of theories of international peace and security, with attention to the concept of linkage between domestic and international politics. Concepts and practices of arms limitation and conflict resolution and of integration and community building at the international level. 4 credits.

**\*776./876. STRATEGY AND NATIONAL SECURITY POLICY**  
Defense and deterrence considerations among the United States and other major powers, including consideration of the levels of armed violence affecting international politics and changes in the nature of war, including impact of modern weapons systems and corollary arms limitation problems. Attention also given to the development of defense policy and the role of armed force establishments in shaping defense policy in the U.S. and elsewhere. 4 credits.

**\*777./877. INTERNATIONAL LAW**  
Formalized processes for regularizing state behavior, as reflected especially in the development of norms based on custom, precedent, and formal institutions, as in treaties and cases. Attention given to arms reduction and limitation arrangement, inspection, and other formal arrangements designed to preserve peace. 4 credits.

**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 credits.

**\*779./879. FOREIGN POLICIES IN EUROPE**  
The interaction of major European states, with attention to East-West relations, security alliances, forms of economic and political cooperation, and the impact of domestic change and superpower relationships on international politics in Europe. 4 credits.

**780./880. FOREIGN POLICIES OF THE USSR AND THE SOVIET BLOC**  
The development of Soviet foreign policy and strategy in its national and European coalition context, with attention to Soviet-American and Sino-Soviet relations. 4 credits.

## \*781./881. INTERNATIONAL POLITICS OF EAST ASIA

Foreign and defense policies of the major East Asian states, with emphasis on Japan, China, and selected Southeast Asian nations. Special attention to the issues and problems where the separate states' interests interact. 4 credits.

## 797./897, 798./898. SECTION (5): SEMINAR IN INTERNATIONAL POLITICS

Small-group discussion, including individual research, on problems in international politics with emphasis on developments in theory. 4 credits.

## 899. SECTION 1: DIRECTED RESEARCH AND STUDY

4 credits.

## 899. SECTION 2: MASTER'S THESIS

4 credits.

## Psychology (76)

**Chairman:** Gordon A. Haaland

**PROFESSORS:** Raymond L. Erickson, John A. Nevin, Ronald E. Shor, Robert I. Watson

**ASSOCIATE PROFESSORS:** Lance K. Canon, Robert G. Congdon, Rand B. Evans, Kirk E. Farnsworth, Peter S. Fernald, G. Alfred Forsyth, Gordon A. Haaland, Earl C. Hagstrom

**ASSISTANT PROFESSORS:** Gregory J. Bertsch, James R. Davis, Leslie A. Fox, John E. Limber, David I. Schickedanz, Marty J. Schmidt, Stephen J. Weber, Daniel C. Williams

## 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 carry out sound research in an area of specialization and make meaningful contributions to the field of psychology. In addition, a concern with the specific needs of the research psychologist who intends to become a college or university teacher is woven into the program. In the third year, students have the opportunity to teach a small section of introductory psychology under close staff supervision while concurrently enrolled in a teaching seminar that has among its goals a deepening of the student's appreciation of the objective and problems of teaching in the liberal arts.

Areas in which the student may specialize are: history and theory, learning, physiological psychology, perception-cognition, and social psychology. The student's adviser will counsel him to help plan an effective graduate program, which will typically require four years. 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.

Social psychology is an interdisciplinary program operated in conjunction with the Sociology Department. Students are admitted by and must meet the requirements of their respective departments. Their work in social psychology, however, is coordinated by an advisory committee with representatives from both departments and includes course work in both departments.

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.

# Psychology

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## Graduate Curriculum in Psychology

The courses and seminars listed below provide the general framework within which the student will develop, with the counsel of his 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 credit.

### 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 credits.

### 807. RESEARCH METHODOLOGY AND STATISTICS III

A continuation of Psychology 805-806, covering computer techniques in statistical analysis, factor analysis, and other commonly used multivariate analytical techniques. 3 credits.

### 808. MEASUREMENT AND ASSESSMENT

A seminar devoted to the nature of measurement in psychology. Emphasis is given both to the techniques for evaluating various assessment procedures and to the theory of data. Current issues in the problems of measurement will be discussed and the course will culminate in a project relating

the area of measurement to specific content areas of interest to the student. Prerequisite: Psychology 807. 3 credits.

### 812. PSYCHOLINGUISTICS

Issues relevant to the development, structure, and foundations of language. Topics include the problem of meaning, acquisition of grammar by the child, personality and voice, and the interrelationship of language and culture. 3 credits.

### 814. COGNITIVE PROCESSES

A study of 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 credits.

### 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 credits.

### 816. INFORMATION, FEEDBACK, AND DECISION MAKING

A seminar devoted to the study of the roles of uncertainty and preference in purposive behavior. Theories and research pertaining to three major topics are considered: the roles of information and uncertainty in behavior, the roles and interaction of feedback and objectives in structured behavior, and the role of preference and its interaction with uncertainty in decision making. 3 credits.

### 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 areas: 1) Physics of visual and auditory stimuli; 2) Sensory Phys-

iology 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 credits.

## **831. PHYSIOLOGICAL PSYCHOLOGY I**

The examination of the concepts and research methods involved in the relationship between the nervous system and behavior. Topics examined include neuroanatomy and the physiological mechanisms of motivation and learning. 3 credits.

## **832. PHYSIOLOGICAL PSYCHOLOGY II**

Continuation of a two-semester sequence examining the concepts and research methods involved in the relationship between the nervous system and behavior. Topics examined include electrophysiological techniques and the analysis of coding in the sensory systems. 3 credits.

## **833. ADVANCED PHYSIOLOGICAL PSYCHOLOGY**

A seminar devoted to an intensive examination of specific topics relating behavior to its physiological correlates. Among the topics considered are receptor functions, cortical mechanisms, memory, neural correlates of drive states, emotional behavior, and intracranial stimulation. Prerequisite: Psychology 831-832 or equivalent. 3 credits.

## **841. PSYCHOLOGY OF LEARNING**

This course has been designed for graduate students lacking a strong undergraduate preparation in the area of learning. Responsibility for instruction is shared by all faculty whose research interests are in the area of learning. Topics include conditioning and other forms of learning, with emphasis on current experimental and theoretical literature. 3 credits.

## **842. STIMULUS CONTROL**

Current research and theory dealing with the control of learned behavior by antecedent and current environmental stimuli. Topics include stimulus generalization, discrimination learning, selective attention, complex operant behavior, and animal psychophysics. Prerequisite: Psychology 841 or equivalent. 3 credits.

## **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, punish-

ment, 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: Psychology 841 or equivalent. 3 credits.

## **844. SEMINAR IN HUMAN LEARNING**

An investigation of learning on the human level. Topics include verbal learning, memory processes, transfer, concept learning, and observational learning. Following a comprehensive treatment of the topics, each student will pursue a specialized area in depth and will present, in both written and oral form, a research proposal for a feasible study in human learning. Prerequisite: Psychology 841 or equivalent. 3 credits.

## **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: Psychology 805, Sociology 801 or equivalent. 3 credits.

## **851. SOCIAL PSYCHOLOGY**

A seminar devoted to theoretical and experimental support for major topics of current concern. These may include attitude change, power, interpersonal perception and attraction, roles, interaction, and analysis of structure and function in complex social systems. 3 credits.

## **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. To be examined are theories emerging from the Gestalt-Freud traditions as well as those developing out of the classical and operant-conditioning approaches. Prerequisite: Psychology 851. 3 credits.

## **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. This course focuses on social influence as a decision-analysis problem with attention to topics such as conformity, leadership, bargaining and negotia-

# Psychology

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tion, group problem-solving, and other variables of group process. Prerequisite: Psychology 851 or permission of instructor. 3 credits.

## 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: Psychology 851. 3 credits.

## 856. PSYCHOLOGY OF PERSONALITY

The evolutionary development of the major personality theories, with particular reference to the theoretical, clinical, and experimental contributions to current theories. 3 credits.

## 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 credits.

## 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 emphases on those most directly applicable to the study of the behavioral sciences. Prerequisite: Psychology 871 or permission of the instructor. 3 credits.

## 873. SYSTEMS, SCHOOLS, AND CONCEPTS IN PSYCHOLOGY

An analysis of the principle schools of psychological thought viewed within the context of the philosophy of science. Prerequisite: Psychology 871 or permission of the instructor. 3 credits.

## 874. PROBLEM AREAS IN THE HISTORY OF PSYCHOLOGY

A study in depth into particular men, movements, and concepts in the history of psychological thought. Topics will vary and it is expected that students in the history of psychology program will sample a number of such topics. Prerequisites: Psychology 871, 872, or permission of instructor.

## 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: Psychology 871, 872, or permission of instructor. 3 credits.

## 876. ADVANCED TOPICS IN HISTORICAL METHODS

A study of methods of historical research with particular emphasis on the development of new quantitative tools and the refining of existing tools. The extension of psychological principles into the history of science will also be discussed. Topics and emphases may vary. May be taken more than once as topics vary. Prerequisites: Psychology 871, 872, or permission of instructor. 3 credits.

## 881. SEMINAR IN DEVELOPMENTAL PSYCHOLOGY

A seminar devoted to topics of current interest in developmental psychology in the areas of infancy, effects of early experience, cognitive development or social-personality development. Core material will be followed by in-depth study in an area of student's interest. 3 credits.

## 891-892. SEMINAR AND PRACTICUM IN THE TEACHING OF PSYCHOLOGY

Typical problems encountered in teaching psychology on the college level, including an examination of the implications of the liberal arts philosophy for teaching. Under close supervision of the staff, the student will be given an opportunity to teach an undergraduate section of introductory psychology. The seminar and practicum operate in close coordination throughout the year. Required of all doctoral students, typically during the third year. 5 credits.

## 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 Psychology 899 will satisfy the department's research requirement for the master's degree. Staff. May be taken for 3 credits per semester in each of two semesters or 6 credits in one semester. Maximum 6 credits.

## 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. The project may involve library research, empirical research, or both. Registration must be acceptable to the student's guidance committee and to the staff member who has agreed to serve as his adviser on the project. May be repeated. 1) Physiological, 2) Perception, 3) History and Theory, 4) Learning, 5) Social, 6) Cognition, 7) Statistics and Methodology, 8) Psychopathology. Staff. 3-6 credits per semester.

## 897-898. PROBLEMS AND ISSUES IN PSYCHOLOGY

A seminar to be offered by one or more members of the staff, concerning problems and issues of special importance in the current development of the field. On occasion, 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. Staff. 3 credits.

## 899. MASTER'S THESIS

Each student will carry out original research that culminates in a master's thesis. May be taken 3 credits per semester in each of two semesters or 6 credits in one semester. Maximum 6 credits.

## 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 credits. (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 lecture; 1 laboratory; 4 credits, to be granted only after the student has passed the companion course, Psychology 825, Use of Individual Intelligence Tests.

## 824. PRACTICUM IN INDIVIDUAL INTELLIGENCE TESTING

Supervised experience in use of individual intelligence tests in elementary and junior high school settings. Prerequisites: Psychology 823 or equivalent, and permission of instructor. 2 credits, to be granted only after the student has passed Psychology 825, Use of Individual Intelligence Tests. Psychology 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: Psychology 823, Psychology 824, which may be taken concurrently; permission of the instructor. 3 credits.

## Sociology (82)

**Chairman:** Richard E. Downs

**PROFESSORS:** Walter Buckley, Richard S. Dewey, Stuart Palmer, Solomon Poll, Murray A. Straus

**ASSOCIATE PROFESSORS:** Melvin T. Bobick, Thomas R. Burns, Peter Dodge, Richard E. Downs, Bud B. Khrief, Arnold S. Linsky, Fred Samuels

**ASSISTANT PROFESSORS:** Loren Cobb, Michael E. Hayes, Stephen P. Reyna, Howard M. Shapiro

**DIRECTOR OF GRADUATE STUDIES:** Thomas R. Burns

The Department of Sociology and Anthropology offers M.A. and Ph.D. degrees in Sociology. The master's degree program emphasizes theory and methodology. Students in the doctoral program

## Sociology

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are expected to select from the areas of departmental specialization one major area—and from the areas of expertise found among the faculty, one minor area—for intensive study and examination. There are three major substantive areas for possible specialization: deviance, conflict, and control; social psychology; comparative institutional analysis. In addition, students may propose to the graduate committee other major areas of specialization which fall within the faculty's competence.

Social Psychology is an interdisciplinary program operated in conjunction with the Psychology Department. Students are admitted by and meet the requirements of their respective departments. Their work in social psychology, however, is coordinated by an advisory committee with representatives from both departments and includes course work in both departments.

The student's proficiency in theory, statistics, and methods, and in the major and minor areas of study is determined by an examination composed of written and oral sections. 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 under the supervision of assigned faculty members, the student is expected to select from the departmental specializations one major area for intensive study, and also with the approval of his adviser and the Graduate Committee to design a minor area tailored to his particular interests from the balance of the curriculum offered by the department—including anthropology courses. In addition, a student is expected to give evidence of satisfactory performance in an extra-departmental field that has also been approved as appropriate to his professional development. The design of a program most suitable to the individual will take into consideration both his past experience and his intellectual goals, and, given the guidelines sketched above, flexibility will be emphasized. The selection of thesis and dissertation topics is thus limited only by the areas of expertise available among departmental faculty members.

Upon establishing residence the student shall inform himself about any modifications in the requirements of the degree program in which he is enrolled.

To be awarded the Master of Arts degree the candidate must fulfill the following requirements: (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 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 an oral and written examination in his major and minor areas of sociological specialization and in advanced theory and methodology. (4) Demonstrate reading level proficiency in a foreign language or a research tool appropriate to the overall program of the student. If the research tool option is chosen, it must not be part of the other degree requirement for graduate students in sociology. Examples of such research tools include computer programming, symbolic logic, historiography, econometric techniques, and mathematical statistics. At the time they are admitted to the Ph.D. program, students must submit for approval by the Graduate Committee a statement indicating how they intend to meet the language/research tool requirement. (5) Fulfill the research and/or teaching requirement described below. (6) Write and defend an acceptable doctoral dissertation.

In planning his 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 own, but he will be permitted to take courses outside the department or below the 700-level within the department only with the express permission of his adviser.

Students are permitted to register for Reading and Research in Sociology and Anthropology (895, 896) to pursue their individual interests. Any and all course work, including required course work, may be satisfied through the directed study. Upon completion, work done under this rubric will be reported, in writing, to the Graduate Committee and the student's adviser by the faculty member who assumes the responsibility for supervising such activities, specifying a) the area within which the work was done, and b) the general content of the course experience achieved by the student.

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, his needed areas of training, and the interests and preferences expressed by the students and faculty members.

To be accepted as a graduate student in sociology, the applicant must present, in addition to meeting the general Graduate School requirements, Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and his score on the advanced test in sociology. 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.

## 703. CRIMINOLOGY

The scientific study and control of crime. The following are considered: indexes, rates and theories of crime and delinquency, police, courts, probation, prison, and parole. 4 credits.

## 720. CURRENT DEVELOPMENTS IN FAMILY SOCIOLOGY

Study of the theoretical and empirical research on specific aspects of the family. A different topic will be selected each semester to reflect issues of current importance, for example: stratification and the family, intra-family communication, power structure of the family, kinship in modern societies. In addition to critical review of the literature, a class or individual research project will usually be carried out. Prerequisite: 8 credits of sociology; Sociology 520, The Family, recommended. 4 credits.

## 721. FAMILY INTERACTION

Relationships of family members to one another and the influence of family interaction on human behavior. The interactionist and role approach is used. Research which relates to scientific knowledge of family interaction is analyzed. Prerequisites: 8 credits in sociology and/or psychology; Sociology 500, Social Psychology, recommended. 4 credits.

## 731, 732. AREA STUDIES IN ARCHAEOLOGY

Courses in the archaeology of different areas of the world will

be offered as staff is available and student needs dictate. Section 1: South America: An introduction to the archaeology of South American beginning with earliest known remains and progressing up to the level of the various culture groups which existed at the time of European contact. Particular emphasis will be placed on the changing relationship of culture and environment through time. Prerequisite: Sociology 412, Physical Anthropology and Prehistoric Archaeology, or permission of instructor. 4 credits.

## 735. COMPLEX ORGANIZATIONS

Analysis of the structure and dynamics of complex, formal organizations (business, military, political and governmental, and educational). Emphasis on the construction of theory to account for the findings of empirical studies, both historical and comparative. Special problems treated in the course: 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 credits.

## 740. CULTURE CHANGE

Various types of society are studied with a view to the development of a theory of culture change. Descriptive studies of institutional as well as theoretical materials, selected from the writing of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. Prerequisite: Sociology 400, Introductory Sociology, or permission of instructor. 4 credits.

## 741. SOCIAL CHANGE AND SOCIETAL DEVELOPMENT

Comparative, interdisciplinary approach to the study of social change. The course focuses on the interrelationships among economic, political, and social factors in determining the structure, dynamics, character, and level of development of societies. Prerequisite: permission of instructor. 4 credits.

## 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: junior standing and Sociology 400, Introductory Sociology. 4 credits.

## 747. NATIVE CULTURES OF SOUTH AMERICA

A survey of the indigenous cultures of South America. Selected groups of people from the major ecological areas of South America will be studied with an emphasis on the relationship of environment and culture. Where there are adequate historical

# Sociology

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data, changes in culture and social organization since the 16th century will be considered. 4 credits.

## 752. SOCIAL PROBLEMS IN MODERN AFRICA

The focus will be on urban and rural adjustments (acculturation) of tribal systems in Africa (below the Sahara) to the 20th century. Prerequisite: Sociology 400 or 411, Introductory Sociology or Cultural Anthropology. A background in sociological theory and methods is desirable. 4 credits.

## 757. SOCIAL INSTITUTIONS OF LATIN AMERICA AND THE CARIBBEAN

Selective analysis of distinctive institutions and social systems, with particular attention to social aspects of the process of modernization. Prerequisite: permission of instructor. 4 credits.

## 761. POPULATION DYNAMICS

Examination of 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. Emphasis is on the interrelationship of population and society. 4 credits.

## 770. CULTURE, PERSONALITY, AND SOCIETY

Emergence of personality from the matrix of genetic, situational, and socio-cultural determinants viewed in cross-cultural perspective; dynamic interplay of the sociocultural and psychological behavior systems. Prerequisite: any two courses from Sociology 400, 411, or Psychology 401, Introductory Sociology, Cultural Anthropology, or Introduction to Psychology. 4 credits.

## 775. ANTHROPOLOGICAL THEORY

An examination of the major theoretical approaches in anthropology viewed in historical perspective. Prerequisite: Sociology 411, Physical Anthropology and Prehistoric Archaeology, or permission of instructor. 4 credits. Offered in alternate years.

## 780. SOCIAL CONFLICT

The nature of social conflict, especially war, will be investigated. The setting and initiation of conflict, its dynamics, and the factors affecting its course and outcome will be analyzed. Prerequisite: permission of instructor. 4 credits.

## 785. THE STUDY OF WORK

This course is centered on the assumption that to understand society, one needs to understand the structure of work. Case

studies of high-status and low-status occupations are used as clues to a larger perspective—an awareness of social processes and interrelationships in the social structure. The student is encouraged to study occupations in an ethnographic manner. Graduate students may enroll only with permission of instructor. 4 credits.

## 790. APPLIED SOCIOLOGY

The practical application of sociological research, including: (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 of his choice and write a paper covering the above issues. Students will be involved in applied projects where possible. Prerequisite: Sociology 601, Methods of Research. 4 credits.

## 801. SOCIOLOGICAL METHODS I. INTERMEDIATE SOCIAL STATISTICS

Application of descriptive and inductive statistical methods to the analysis of sociological data, including sampling distributions, statistical decision-making, analysis of variance, correlation and regression, and nonparametric measures. Prerequisite: Sociology 601, Methods of Social Research, or permission of instructor. 4 credits.

## 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: Sociology 601, Methods of Social Research and 602, Social Statistics, or their equivalent, or permission of instructor. 4 credits.

## 803. SOCIOLOGICAL METHODS III. SPECIAL PROBLEMS IN METHODS AND STATISTICS

Attention is focused on one or more special problems in sociological research, such as the following: measurement and scaling, field and laboratory experiments in sociology, multivariate analysis, historical methods, community studies, mathematical models in sociological research, and survey design and analysis. Prerequisites: Sociology 801, and Sociology 802 or Psychology 809. 4 credits.

## 811. SOCIOLOGICAL THEORY I

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. Prerequisites: Sociology 611, History of Social Theory,

and 612, Contemporary Sociological Theory, or their equivalents. 4 credits.

## **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 particular interests in substantive areas. Prerequisite: Sociology 811. 4 credits.

## **813. SOCIOLOGICAL THEORY III**

A seminar of intensive study of specific figures and movements in sociological theory. Sample topics include: Max Weber; evolution, pragmatism, and reform and classical social theory. Prerequisites: Sociology 611, History of Social Theory, and 612, Contemporary Sociological Theory, or their equivalents. 4 credits.

## **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 credits.

## **830. THE SMALL GROUP**

The small group as a unit for sociological study, for the testing and the developing of hypotheses. Both the behavior and the attitudinal levels shall be considered with respect to group intra-action and group-to-group interaction. The effects of different independent variables upon group structures shall be of particular interest. Prerequisite: a course in social psychology, or permission of instructor. 4 credits.

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

This course emphasizes viewing schools in their socio-cultural context; it is centered on a number of field studies of urban and suburban communities. Among the topics discussed are the following: (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 credits. (Also offered as Education 838.)

## **850. METHODS OF SOCIAL PSYCHOLOGICAL ANALYSIS**

An examination of the 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 their lethality, and other current methodological issues. The course emphasizes the design of social psychological research rather than statistical analysis, though statistical matters regularly arise. Graduate level sophistication in statistics is assumed. 4 credits. (Also offered as Psychology 850.)

## **851. SEMINAR IN SOCIAL PSYCHOLOGY**

A seminar devoted to theoretical and experimental support for major topics of current concern. These may include attitude change, power, interpersonal perception and attraction, roles, interaction, and analysis of structure and function in complex social systems. Prerequisite: permission of instructor. 4 credits. (Also offered as Psychology 851.)

## **852. SOCIALIZATION AND ABNORMAL BEHAVIOR**

A seminar concerned with socialization and the effects of socialization on abnormal behavior. A survey of those orientations that relate socialization to abnormal behavior with the aim of synthesizing the major concepts into current sociological and social-psychological frames of reference. In addition, emphasis will be placed on the methodological problems of research concerned with socialization. Prerequisite: at least one course in social psychology or permission of instructor. 4 credits.

## **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 credits.

## **861. DEMOGRAPHY**

Survey and analysis of current problem areas in demography, including: fertility, mortality, migration, population growth, population theory, formal demography, and the use of demographic sources and techniques in sociological investigation. Prerequisite: Sociology 761 or permission of instructor. 4 credits.

## Spanish and Classics

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### 870. COMPARATIVE INSTITUTIONAL ANALYSIS

Theoretical and methodological aspects of cross-national comparative research in sociology, including: history of comparative research, examination of differences in objectives and methods employed, problems of translation and conceptual equivalence of behaviors and indexes, and field techniques. Prerequisites: Sociology 601, Methods of Social Research, and 602, Social Statistics. 4 credits.

### 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 credits.

### 885. OCCUPATIONS AND PROFESSIONS

Professionalization is discussed as adult socialization, an acquisition of a new identity; professions are explored as ideologies and as extended families. Low-status and high-status occupations are compared with regard to the way their members are recruited and trained, their career stages, work problems, and role-sets. A symbolic interactionist approach is adopted; issues of work are considered in their socio-cultural and institutional contexts; a number of the Chicago studies of occupations are examined. 4 credits.

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

The two cultures are treated as a unit; culture change is discussed. Issues of current interest are explored, e.g., poverty, school desegregation, the schooling of geographically-mobile children, problems of social mobility and abundance, the rise of the counseling and healing trades, and teachers' quest for professionalism. The education of culturally deprived and culturally endowed children receives special attention. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. 4 credits. (Also offered as Education 888).

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

This course deals with ethnic stratification and inter-group

processes both inside and outside the school. The public schooling of disadvantaged groups such as black, Indian, white Appalachian, and Mexican Americans, receives special attention. Caste and class relations between schoolmen, parents, and pupils are examined within such contexts as slums, reservations, Levittowns, and "golden ghettos." A socio-anthropological perspective is emphasized. 4 credits. (Also offered as Education 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 Sociology 895, 896. Prerequisite: permission of instructor. 4 credits.

### 899. MASTER'S THESIS

Usually 6 credits, but up to 10 credits when the problem warrants.

### 999. DOCTORAL RESEARCH

## Spanish and Classics (77)

**Chairman:** John C. Rouman, Associate Professor of Classics

**PROFESSOR:** R. Alberto Casas

**ASSOCIATE PROFESSORS:** Richard J. Callan, Charles H. Leighton

**ASSISTANT PROFESSOR:** F. William Forbes, Assistant Chairman for Spanish

The Department of Spanish and Classics 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).

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 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. If he fails in his first attempt, he 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 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 chairman.

## Spanish (77)

### 701,703. CATALAN

An introduction to Catalan grammar and literature. Semester 1: study of the linguistic elements of Catalan, especially in its contrasts with other Romance languages, and basic readings in

Catalan. Semester II: a survey of Catalan literature from the Middle Ages to the present. Prerequisite: completion of an intermediate-level course in Latin or one of the Romance languages, or permission of instructor. 4 credits.

### 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 credit.

### 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 credit.

### 811. MEDIEVAL SPANISH LITERATURE

Study of a topic or topics in Spanish literature of the period 1100-1500. Works normally to be studied include Berceo, the *Libro de buen amor*, the poetic schools of the 15th century, and *La Celestina*. Social and historical backgrounds of the period. Conducted in Spanish. 3 credits.

### 831. RIVER PLATE LITERATURE

Sarmiento, Jose Hernandez, Rodo, Florencio Sanchez, Mallea. Focus on the question of *argentinidad*. Conducted in Spanish. 3 credits. (Offered alternate years.)

### 852. DRAMA AND POETRY OF THE SIGLO DE ORO

The social background of the Baroque period. Readings of representative plays of Lope de Vega, Tirso de Molina, Calderon, and the poetry of Lope, Gongora, and Quevedo. Development of the prose of the period. Conducted in Spanish. 4 credits.

### 854. CERVANTES

The development of Cervantes' literary art. Reading and discussion of selections from all the major works of Cervantes. Comprehensive study of the *Quixote*, its originality and significance; its antecedents; its religious, philosophical and sociological aspects, and its artistic structure. Conducted in Spanish. 4 credits.

### 857. THEATER AND POETRY OF THE TWENTIETH CENTURY

Critical analysis, reports, and discussion of the major developments in poetry and the drama of the twentieth century, beginning with the Generation of '98. Major writers to be studied

## Zoology

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will include Benavente, Machado, J.R. Jimenez, Garcia Lorca, Casona, Sastre, Buero Vallejo, Damaso Alonso, and Miguel Hernandez. Conducted in Spanish. 4 credits. (Offered alternate years.)

### 858. SPANISH PROSE OF THE TWENTIETH CENTURY

Readings and discussion of the novels, short stories, and essays of such major writers of the twentieth century as Unamuno, Baroja, Menendez Pidal, Ortega y Gasset, Julian Marias, Aranguren, Perez de Ayala, Gironella, and Cela, as well as a survey of contemporary prose. Conducted in Spanish 4 credits. (Offered alternate years.)

### 860. UNAMUNO AND ORTEGA Y GASSET

Critical examination of the philosophical ideology and literary content of the major contributions of Miguel de Unamuno and Jose Ortega y Gasset. 4 credits. (Offered alternate years.)

### 871. SPANISH-AMERICAN DRAMA

From pre-Hispanic origins to the present, with emphasis on the modern playwrights of Mexico and Puerto Rico. Conducted in Spanish. 4 credits. (Offered alternate years.)

### 872. SPANISH-AMERICAN NOVEL

Development of the genre from Romanticism to present-day writers, with special emphasis on contemporary trends and techniques. Conducted in Spanish. 4 credits. (Offered alternate years.)

### 873. SPANISH-AMERICAN SHORT STORY

Development of the genre through study of representative authors, with stress on the twentieth century. Principles of interpretation. Conducted in Spanish. 4 credits. (Offered alternate years.)

### 874. SPANISH-AMERICAN POETRY

Discussion of major poets from *modernismo* to the post-Vanguard movements: Dario, Huidobro, Mistral, Vallejo, Octavio Paz. Conducted in Spanish. 4 credits. (Offered alternate years.)

### 891. METHODS OF FOREIGN LANGUAGE TEACHING

A critical study of the objectives, methods, and techniques used in teaching Spanish at all levels from elementary through college. Discussion, demonstration, preparation of instructional materials, and micro-teaching of the language skills. Prerequisite: permission of the instructor. 3 credits.

### 895, 896. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE

Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Staff. Conducted in Spanish. Prerequisite: permission of department chairman. R1. History of the Spanish Language; R2. Medieval Spanish Literature; R3. Spanish Literature of the Renaissance; R4. Spanish Literature of the Golden Age; R5. Spanish Literature of the 18th, 19th Century; R6. Spanish Literature of the 20th Century; R7. Contemporary Spanish Literature; R8. Spanish American Literature of the 16th and 17th Centuries; R9. Spanish American Literature of the 18th and 19th Centuries; R10. Spanish American Literature of the 20th Century; R11. Contemporary Spanish American Literature; R12. Structural and Applied Linguistics; R13. Spanish Literary Criticism; R14. Spanish American Drama; R15. Latin America; R16. Linguistic Problems of Disabled Children; R17. Major Spanish American Authors; R18. Spanish Poetry; R19. Galdos; R20. Archetype Latin American Literature; R21. Special Teaching Problems; R22. Spanish Civilization and Culture; R23. Latin American Civilization and Culture; R24. Borges; R25. Spanish Theater. Variable credit.

### 899. MASTER'S THESIS

6 credits.

## Zoology (84)

**Chairman:** 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, Frank K. Hoornbeek, Marcel E. Lavoie, John J. Sasner, Edward K. Tillinghast

**ASSISTANT PROFESSORS:** Edward N. Francq, James F. Haney, Larry G. Harris, E.H. Wheeler, Jr.

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, mammology, biological oceanography, parasitology, and physiology. The graduate program in Biology is designed for teachers in secondary schools (page 36).

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, background in chemistry through organic chemistry, a semester each of calculus and physics is necessary. A reading knowledge of one foreign language is required for all departmental Ph.D. programs; many areas of specialty require a knowledge of two foreign languages. 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 in the week prior to the beginning of classes for the fall 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 committee will have at the time of the interview the student's complete folder containing transcripts, letters of recommendation, etc. The purpose of the committee is to review the student's records with him, ask general questions about the depth and scope of the courses taken, and to determine the specific areas in which the student has deficiency.

All beginning graduate students in Zoology will be required to pass oral examinations in General Biology and in four of the following eight fields: behavior, biochemistry and physiology, development, ecology, evolution and systematics, genetics, morphology, and parasitology. Normally, this examination will be passed by the end of the second year of graduate work, but must be taken during the first year of residence. This examination may function in partial satisfaction of the master's degree requirements, or to identify academic deficiencies in students who wish to proceed to doctoral candidacy. If the deficiencies revealed are regarded by the Zoology faculty as sufficiently serious, the student's tenure may be terminated, or he may be allowed a second examination after additional preparation.

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 his guidance committee.

In addition to the language requirements, and after the successful completion of all required courses, the student who wishes to be admitted to doctoral candidacy must demonstrate a broad basic knowledge of his major and minor fields in an oral qualifying examination, administered by his doctoral committee. In addition, he must convince his proposed major professor and doctoral committee, in whatever way the committee finds acceptable, of his superior capacity to carry out basic research in biology. Normally, the student may accomplish this by presenting to his

committee a research proposal in which the soundness, originality, and feasibility of his investigative ideas are clearly revealed, and which—when approved—should serve as the basis of his doctoral dissertation.

### 703. GENERAL AND COMPARATIVE GENETICS

Comparative analysis of genetic systems, with emphasis given to diploids and the role of gene and chromosome mutations in their evolution. Evolution of dominance and sex determination. Consideration will also be given to techniques useful in statistical and experimental approaches to analyses of diploid inheritance. Mr. Hoornbeek. Prerequisite: Zoology 604, Principles of Genetics, or equivalent. 4 credits.

### 704. COMPARATIVE ENDOCRINOLOGY

The various endocrine organs are considered in their relationship to control of the internal environment, growth, development, and adaptation to the external environment. Mr. Tillinghast. Prerequisites: vertebrate anatomy and physiology, and organic chemistry. 4 credits.

### 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: Zoology 604, Principles of Genetics, or equivalent, and permission of instructor. 2 credits.

### 711. NATURAL HISTORY OF COLD-BLOODED VERTEBRATES

The various classes of poikilothermic vertebrates, their habits, habitats, and life histories, with special reference to those occurring in eastern North America. Mr. Sawyer. Prerequisites: general zoology and Zoology 518, Vertebrate Morphology. 4 credits.

### (712). MAMMALOLOGY

The origin and diversification of mammals, their ecology and economic importance. Laboratories will emphasize techniques of the mammalogist and identification of local forms. Mr. Francq. Prerequisites: general zoology and Zoology 508, Human Anatomy and Physiology. 4 credits. (Alternate years; offered in 1975-76.)

### (713). ANIMAL BEHAVIOR

Individual and group behavior of animals, including the role of anatomy, physiology, and prior experience, and the ecological significance of behavioral mechanisms. Techniques and the practical application of the study of animal behavior. Mr. Francq. Prerequisite: one year of zoology. 4 credits.

# Zoology

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## 715. NATURAL HISTORY OF MARINE INVERTEBRATES

A field and laboratory course designed to acquaint the student with the inshore marine invertebrate metazoan animals of northern New England. Emphasis will be on identification, classification, habitat preferences, and behavior of these animals. Field work (collection and observation) will constitute a major part of the course, and the student must be prepared to assume some travel expense. Staff. Prerequisite: general zoology. 4 credits. (Offered in Summer 1974.)

## 717. GENERAL LIMNOLOGY

An introduction to the special relationships of freshwater organisms to the chemical, physical, and biological aspects of the aquatic environment. Emphasis on factors regulating the distribution of organisms and primary and secondary productivity of lake habitats. Prerequisite: Biology 541, General Ecology, or equivalent. 4 credits.

## 719. FIELD LIMNOLOGY

Principles of freshwater ecology are examined through laboratory exercises dealing with a variety of freshwater habitats. Stress placed on the methods used to study freshwater lakes and interpretation of data. Includes a seminar series and occasional Saturday field trips. Prerequisites: present or prior enrollment in Botany 717, Zoology 717, General Limnology, or equivalent and permission of instructor. 3 credits.

## 721. PARASITOLOGY

A study of some of the more important parasites causing disease of man and animals. Living materials will be used as far as possible. Mr. Bullock. Prerequisite: one year of zoology. 4 credits.

## 723. CELL PHYSIOLOGY

Application of the principles of chemistry and physics to the understanding of cell structure and function. Metabolic reactions and their control are considered in relation to cell organization. Treatment is also given to the genesis and function of specialized cells. Mr. Tillinghast. Prerequisite: organic chemistry. 4 credits.

## (724). MARINE PARASITOLOGY

A study of the diseases and parasites of marine fish and shellfish with particular reference to the local estuarine environment. Mr. Bullock. Prerequisite: Zoology 508, Human Anatomy and Physiology, or 518, Vertebrate Morphology, or equivalent and a course in invertebrate zoology. 4 credits. (Offered in 1974-75.)

## 726. GENERAL PHYSIOLOGY

A study of some of the physical and chemical phenomena common to all biological systems. Special emphasis is placed on membranes, permeability, excitability, conductivity, contractility and bioenergetics. Mr. Sasner. Prerequisites: organic chemistry, physics, and one year of zoology. 4 credits.

## 729. VERTEBRATE EMBRYOLOGY

The fundamental principles of vertebrate growth and development, including metamorphosis, regeneration, and aging as well as embryonic development. Mr. Foret. Prerequisites: Zoology 518, Vertebrate Morphology, 527, Vertebrate Physiology, and 604, Principles of Genetics, or equivalents. 4 credits.

## 730. HISTOLOGY AND MICROTECHNIC

The microscopic anatomy of tissues and organs of vertebrates and an introduction to routine techniques used in such studies. Prerequisite: Zoology 508, Human Anatomy and Physiology, or 518, Vertebrate Morphology, or equivalent. 1-hour lecture; 6-hour laboratory; 4 credits.

## 772. FISHERIES BIOLOGY

Designed to introduce the student to some of the information and techniques used by the freshwater fisheries biologist. Emphasis on freshwater fisheries, but many of the techniques and some of the readings pertain as well to salt water fisheries. Mr. Sawyer. Prerequisites: Zoology 711 or equivalent, and permission of instructor. 4 credits.

## 774. INTRODUCTION TO MARINE SCIENCE

Daily lectures, laboratory, and field work. Offered at the Isles of Shoals in cooperation with Cornell University and the State University of New York. Summers only. Staff. Prerequisite: at least a full year of College Biology. 5 credits.

## 795, 796. SPECIAL PROBLEMS IN ZOOLOGY

Election of one or more sections of this course provides opportunity for advanced study. Section numbers and subject-matter fields are: (1) Biological Oceanography, (2) Ecology, (3) Endocrinology, (4) Evolution, (5) Developmental Biology, (6) Genetics, (7) Morphology, (8) History of Zoology, (9) Invertebrate Zoology, (10) Physiology, (11) Vertebrate Biology, (12) Zoogeography, (13) Zoological Techniques, (14) Parasitology, (15) Histochemistry, (16) Protozoology, (17) Systematics, (18) Animal Behavior, (19) Teaching Practices. Work may involve reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of staff concerned. 2 or 4 credits. (Limit of 12 credits from the sections of this course.)



## (803). MARINE ECOLOGY

The marine environment and its biota, with emphasis on intertidal and estuarine habitats. Laboratory and field work will stress inquiry and the application of ecological, physiological, behavioral, biometrical, systematic, and chemical techniques to local problems. Field trips may be scheduled for early morning, late afternoons, or weekends. Travel will be at the student's expense, and should not exceed \$30 for the course. Mr. Croker. Prerequisites: Biology 541, General Ecology, and permission of instructor; courses in marine invertebrate zoology, oceanography, and statistics are desirable. 4 credits.

## (806). BIOLOGICAL OCEANOGRAPHY

The ocean as an environment for life, emphasizing oceanic populations, their interrelationships, and their adaptations to an oceanic existence. Field work will include short cruise in the Gulf of Maine aboard R/V *Jere A. Chase*, in addition to a longer cruise aboard R/V *Eastward* in the Gulf Stream and Sargasso Sea. Mr. Wheeler. Prerequisites: Earth Science 501, Introduction to Oceanography, or the equivalent and instructor's permission. 4 credits. (Offered in 1975-76.)

## 811. FRESHWATER ZOOPLANKTON ECOLOGY

Lectures and laboratory exercises on the methods of sampling zooplankton populations, factors regulating their temporal and spatial distribution, trophic interactions of planktonic communities, and role of zooplankton in nutrient cycle of lakes. Field trips will examine the zooplankton communities in varied freshwater habitats. Seminars cover current research papers in the field. Prerequisites: General Ecology and Limnology, Zoology 707, or equivalent and permission of instructor. 4 credits.

## 815. POPULATION ECOLOGY

Lectures and seminars dealing with the evolution, genetic theory, differentiation, and functioning of animal populations. Current literature and research methods will be reviewed. Mr. Wheeler. Prerequisites: one semester of ecology and genetics; courses in calculus and statistics are desirable. 1 lecture; 1 seminar; 4 credits. (Offered in 1974-75.)

## 817. ZOOPLANKTON

Oceanic and estuarine populations of zooplankton: their zoogeography, their ecological relationships within marine food food chains, and their adaptations to the pelagic environment. A research problem will be undertaken aboard R/V *Eastward* in waters of the Gulf Stream and western Sargasso Sea. Mr.

Wheeler. Prerequisites: Invertebrate Zoology and instructor's permission. 4 credits. (Offered in 1974-75.)

## (820), (821). ADVANCED INVERTEBRATE ZOOLOGY

A detailed and comprehensive study of the morphology, phylogeny, and natural history of the major invertebrate phyla in lecture and laboratory. Staff. Prerequisite: Zoology 618, Introduction to Invertebrate Zoology, or equivalent, 4 credits.

## (822). PROTOZOOLOGY

The general biology of Protozoa, with particular emphasis on morphology, natural history, and economic importance. Mr. Borror. Prerequisite: Zoology 721 or 820 or permission of instructor. 4 credits.

## 823. THE HOST-PARASITE RELATIONSHIP

Examination of the interactions of host and parasite, using examples from fish, wildlife, and human parasitology. Particular attention will be given to ways in which host ecology influences parasite populations, and the interplay of host and parasite in parasite pathology and immunology. Mr. Bullock. Previous training in parasitology, histology, and ecology desirable. 4 credits.

## 826. COMPARATIVE PHYSIOLOGY

The means whereby animals, chiefly invertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Sasner. Prerequisite: Zoology 726 or 723. 4 credits.

## 828. EXPERIMENTAL EMBRYOLOGY

An examination of cellular differentiation during development. Laboratories will illustrate important techniques in experimental morphogenesis. Mr. Foret. Prerequisite: Zoology 729 or equivalent. 4 credits.

## 830. INVERTEBRATE EMBRYOLOGY

The developmental patterns as exhibited by the major invertebrate groups. This will be essentially a descriptive study based upon lectures, library, and laboratory work with living material. Prerequisites: Zoology 820, 821. 4 credits. (Not offered in 1975-76.)

## 895, 896. ADVANCED STUDIES IN ZOOLOGY

The sections of this course provide opportunity for advanced work either on an individual or group seminar basis. They may involve reading, laboratory work, organized seminars, and conferences. Prerequisite: permission of department chairman

## Zoology

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and staff concerned. (Sections of this course are the same as those listed under Zoology 795, 796.) 2 or 4 credits.

### **897, 898. ZOOLOGY SEMINAR**

Preparation, presentation, and discussion of reports of recent zoological literature. Subject matter fields are the same as those listed under Zoology 795, 796. Not all areas will be available every semester. Required of graduate students in zoology. Staff. No credit.

### **899. MASTER'S THESIS**

Open to students who wish to do independent, original research. Prerequisite: permission of department chairman and prospective supervisor. 6 credits.

### **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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# Faculty of the Graduate School

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**Ackerman, Margaret D.**

Assistant Professor of Education; Ph.D., University of Pennsylvania, 1971; appointed 1971.

**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.

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Professor of Chemistry; Ph.D., University of Minnesota, 1959; appointed 1960.

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Professor of Resource Economics; Ph.D., University of Minnesota, 1959; appointed 1959.

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Professor of Occupational Education; Ed. D., Cornell University, 1961; appointed 1962.

**Antosiewicz, Rose T.**

Assistant Professor of Italian; Ph.D. University of California at Los Angeles, 1971; appointed 1970.

**Arnoldy, Roger L.**

Associate Professor of Physics; Ph.D., University of Minnesota, 1962; appointed 1967.

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Thompson School Associate Professor of Civil Technology & Adjunct Associate Professor of Civil Engineering; M.S.C.E., Purdue University, 1952; appointed 1953.

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**Bechtell, Homer F., Jr.**

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**Beckett, John A.**

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**Bennett, Albert B.**

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**Betz, George W.**

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**Bogle, Alfred Linn**

Assistant Professor of Botany; Ph.D., University of Minnesota, 1968; appointed 1970.

**Bonner, Thomas N.**

President of the University and Professor of History; Ph.D., Northwestern University, 1952; appointed 1971.

**Bonnice, William E.**

Associate Professor of Mathematics; Ph.D., University of Washington, 1962; appointed 1962;

**Borror, 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.

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**Boynton, Jason E.**

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**Browne, Evelyn**

Professor of Physical Education; M.A., University of New Hampshire, 1962; appointed 1943.

**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.

**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**

Assistant 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.

**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.

**Carter, Gavin H.**

Associate Professor of Physical Education; Ph.D., University of Oregon, 1958; appointed 1965.

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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.

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Associate Professor of Education; Ed.D., Columbia University, 1957; appointed 1967.

**Chasteen, N. Dennis**

Assistant 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.

**Cimbolic, Peter**

Adjunct Assistant Professor of Education; Ph.D., University of Missouri, 1970; appointed 1970.

**Clark, Charles E.**

Associate 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.**

Associate 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.**

Associate Dean of the Whittemore School of Business and Economics and 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.

**Curcio, Ronald P.**

Assistant Professor of Education; Ed.D., Rutgers University, 1969; appointed 1968.

**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 Technology and Professor of Materials Science; Ph.D., University of Toronto, 1954; appointed 1968.

**Davis, Robert M.**

Assistant Professor of French; Ph.D., University of Wisconsin, 1972; appointed 1969.

**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.**

Assistant 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.**

Assistant Professor of Music; Ph.D., Princeton University, 1967; appointed 1968.

**Dewey, Richard S.**

Professor of Sociology; Ph.D., University of Wisconsin, 1941; appointed 1958.

**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.**

Acting Dean of the Graduate School, Coordinator of Research, 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.**

Associate Professor of Resource Economics; M.A., University of New Hampshire, 1951; appointed 1950.

**Durnall, Edward J.**

Director of the Division of Continuing Education and Associate Professor of Education; Ed.D., Oregon State University, 1953; appointed 1966.

**Dykens, James W.**

Adjunct Professor of Social Psychiatry; M.D., University of Vermont, 1945; appointed 1972.

**Eder, Sidney C.**

Assistant Professor of Education; Ph.D., Arizona State University, 1971; appointed 1971.

**Edwards, John C.**

Associate Professor of Speech and Drama; Ph.D., Northwestern University, 1963; appointed 1961.

**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.**

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.

**Faiman, Robert N.**

Vice Provost for Research and Special Program Administration and Professor of Electrical Engineering; Ph.D., Purdue University, 1956; appointed 1959.

**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.

**Farnsworth, Kirk E.**

Adjunct Associate Professor of Psychology; Ph.D., Iowa State University, 1968; appointed 1968.

**Federer, C. Anthony**

Adjunct Associate Professor of Micrometeorology; Ph.D., University of Wisconsin, 1964; appointed 1970.

**Fernald, Peter S.**

Associate Professor of Psychology; Ph.D., Purdue University, 1963; appointed 1966.

**Fink, Stephen L.**

Professor of Organizational Development; Ph.D., 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 1964.

**Fox, Leslie A.**

Assistant Professor of Psychology; Ph.D., University of Washington, 1968; appointed 1968.

**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, 1953; appointed 1964.

**Garrett, Peter W.**

Adjunct Assistant Professor of Forest Genetics; Ph.D., University of Michigan, 1969; appointed 1970.

**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.

**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.

**Greenleaf, William**

Professor of History; Ph.D., Columbia University, 1955; appointed 1958.

**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.

**Haaland, Gordon A.**

Associate Professor of Psychology; Ph.D., State University of New York at Buffalo, 1966; appointed 1965.

**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.

**Hall, Francis R.**

Professor of Hydrology; Ph.D., Stanford University, 1961; appointed 1964.

**Hall, Otis F.**

Professor of Forest Resources; Ph.D., University of Minnesota, 1954; appointed 1968.

**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.

**Happgood, Robert**

Professor of English; Ph.D., University of California, 1955; appointed 1965.



**Harris, Larry G.**

Assistant Professor of Zoology; Ph.D., University of California, 1970; appointed 1969.

**Harter, Robert D.**

Assistant Professor of Soil Chemistry; Ph.D., Purdue University, 1966; appointed 1969.

**Haslerud, George M.**

Professor of Psychology; Ph.D., University of Minnesota, 1934; appointed 1945.

**Haugstad, May Biggs**

Assistant Professor of Botany; Ph.D., The Catholic University of America, 1971; appointed 1969.

**Hayes, Michael E.**

Assistant Professor of Social Work; Ph.D., University of Michigan, 1966; appointed 1973.

**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.

**Held, Warren H., Jr.**

Professor of Classics; Ph.D., Yale University, 1955; appointed 1967.

**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.

**Herr, Guenther K. W.**

Assistant Professor of German; Ph.D., University of Texas, 1966; appointed 1968.

**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.

**Hof, Phyllis**

Associate Professor of Physical Education; Ph.D., University of Southern California, 1967; appointed 1967.

**Hodgdon, Albion R.**

Professor of Botany; Ph.D., Harvard University, 1936; appointed 1930-32, 1936.

**Hogan, John A.**

Carter Professor of Economics; Ph.D., Harvard University, 1952; appointed 1947.

**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.

**Hoorbeek, Frank K.**

Associate Professor of Zoology and Genetics; Ph.D., Oregon State University, 1964; appointed 1964.

**Horrigan, James O.**

Associate 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.

**Hraba, John B.**

Dean, Office of Institutional Research and Planning and Professor of Electrical Engineering; Ph.D., University of Illinois, 1955; appointed 1949.

**Hubbard, Colin D.**

Associate Professor of Chemistry; Ph.D., University of Sheffield, 1964; appointed 1967.

**Hudon, Edna S.**

Associate Professor of French; Ph.D., Yale University, 1955; appointed 1961.

**Hudon, Louis J.**

Professor of French; Ph.D., Yale University, 1943; appointed 1961.

**Hunter, William B., Jr.**

Professor of English; Ph.D., Vanderbilt University, 1946; appointed 1968.

**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, Jesse**

Associate Professor of Occupational Education; M.S., University of Georgia, 1951; appointed 1957.

**James, Marion E.**

Associate Professor of History; Ph.D., Radcliffe College, 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.

**Jervis, Frederick M.**

Adjunct Professor of Education; Ph.D., Columbia University, 1958; appointed 1973.

**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.

**Kemnitz, Thomas M.**

Assistant Professor of History; Ph.D., University of Sussex, 1969; appointed 1969.

**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 1970.

**Kiang, Yun Tzu**

Assistant Professor of Plant Sciences and Genetics; Ph.D., University of California, 1970; appointed 1970.

**Kimball, Roland B.**

Acting Assistant Dean of the Graduate School and Professor of Education; Ed.D., Harvard University, 1958; appointed 1963.

**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.

**Knight, Lewis E.**

Visiting Assistant Professor of Education; Ed.D., Stanford University, 1971; appointed 1973.

**Koch, David W.**

Assistant Professor of Plant Science; Ph.D., Colorado State University, 1971; appointed 1971.

**Korbel, John**

Professor of Economics and Business Administration; Ph.D., Harvard University, 1959; appointed 1966.

**Krieg, Fred J.**

Assistant Professor of Education; Ph.D., Ohio State University, 1971; appointed 1973.

**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 1961.

**Lange, Kenneth L.**

Assistant Professor of Mathematics; Ph.D., Massachusetts Institute of Technology, 1971; appointed 1971.

**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.

**Leak, William B.**

Adjunct Associate Professor of Forest Resources; M.F., S.U.N.Y., College of Forestry, Syracuse University, 1956; appointed 1967.

**Leighton, Charles H.**

Associate Professor of Spanish; Ph.D., Harvard University, 1961; appointed 1956.

**LeRay, Nelson L., Jr.**

Adjunct Associate Professor of Resource Economics; Ed.D., Cornell University, 1965; appointed 1966.

**Limber, John E.**

Assistant Professor of Psychology; Ph.D., University of Illinois, 1968; appointed 1971.

**Limbirt, David E.**

Assistant Professor of Mechanical Engineering; Ph.D., Case Western Reserve University, 1969; appointed 1969.

**Linden, Allen B.**

Assistant 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.**

Acting Assistant Dean of the Graduate School 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.

**Marschner, Donald C.**

Professor of Business Administration; Ph.D., Columbia University, 1964; appointed 1964.

**Marshall, Grover E.**

Assistant Professor of French and Italian; Ph.D., Princeton University, 1971; appointed 1965.

**Marshall, Thomas O.**

Professor of Education; Ed.D., Harvard University, 1941; appointed 1947.

**Mathieson, Arthur C.**

Associate Professor of Botany; Ph.D., University of British Columbia, 1965; appointed 1965.

**Mautz, William W.**

Assistant Professor of Wildlife Ecology; Ph.D., Michigan State University, 1969; appointed 1969.

**McCann, Francis D., Jr.**

Associate Professor of History; Ph.D., Indiana University, 1967; appointed 1971.

**Meagher, Judith A.**

Assistant Professor of Education; Ed.D., Boston University, 1968; appointed 1968.

**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.

**Menell, Robert M.**

Associate Professor of History; Ph.D., Ohio State University, 1969; appointed 1969.

**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.

**Miller, Edmund G.**

Professor of English; Ph.D., Columbia University, 1955; appointed 1951.

**Mills, Eugene S.**

Provost 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.

**Moore, Berrien, III**

Assistant 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.

**Morrison, James D.**

Professor of Chemistry; Ph.D., Northwestern University, 1963; appointed 1965.

**Morrison, Jean M.**

Assistant Professor of Physical Education; M.A., Mills College, 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.

**Murray, Donald M.**

Professor of English; B.A., University of New Hampshire, 1948; appointed 1963.

**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.

**Nielsen, John P.**

Associate Professor of Civil Engineering; Ph.D., Colorado State University, 1961; appointed 1969.

**Nielson, Melville**

Associate Dean of the College of Liberal Arts and Associate Professor of Sociology; Ph.D., Ohio State University, 1955; appointed 1950.

**Nordell, Lawrence P.**

Visiting Associate Professor in Economics; Ph.D., University of California at Berkeley, 1967; appointed 1972.

**Nordgren, Eric A.**

Associate Professor of Mathematics; Ph.D., University of Michigan, 1964; appointed 1964.

**O'Connell, Lawrence W.**

Associate Professor of Political Science; Ph.D., Syracuse University, 1968; appointed 1966.

**Olson, David P.**

Associate Professor of Wildlife Ecology; Ph.D., University of Minnesota, 1964; appointed 1964.

**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 1964.

**Pfanner, Helmut F.**

Associate Professor of German; Ph.D., Stanford University, 1965; appointed 1969.

**Pierce, Robert S.**

Adjunct Associate Professor of Forest Resources and Soil and Water Science; Ph.D., University of Wisconsin, 1957; appointed 1967.

**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.

**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.

**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.**

Assistant Professor of Economics; Ph.D., Northwestern University, 1967; appointed 1967.

**Radlow, James**

Professor of Applied Mathematics; Ph.D., New York University, 1957; appointed 1965.

**Rand, M. Elizabeth**

Associate Professor of Home Economics; M.Ed., Boston University, 1946; appointed 1948.

**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.

**Rehder, Robert M.**

Assistant Professor of English; Ph.D., Princeton University, 1970; appointed 1974.

**Reid, Samuel R.**

Professor of Business Administration and Economics; Ph.D., St. Louis University, 1962; appointed 1969.

**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.

**Ringrose, Richard C.**

Professor of Animal Science; Ph.D., Cornell University, 1936; appointed 1942.

**Roelof, Edmond C.**

Assistant Professor of Physics; Ph.D., University of California at Berkeley, 1966; appointed 1971.

**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.**

Assistant Professor of Russian; Ph.D., Université 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, 1961; 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.

**Rutman, Darrett B.**

Professor of History; Ph.D., University of Virginia, 1959; appointed 1968.

**Sabatelli, Philip J.**

Assistant Professor of Speech and Drama; Ph.D., Temple University, 1970; appointed 1969.

**St. Onge, Richard N.**

Assistant Professor of Physics; Ph.D., University of New Hampshire, 1969; appointed 1970.

**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 I.**

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.

**Schulz, Ann T.**

Assistant Professor of Political Science; Ph.D., Yale University, 1969; appointed 1969.

**Schwarz, Marc L.**

Associate Professor of History; Ph.D., University of California at Los Angeles, 1965; appointed 1967.

**Shapiro, Howard M.**

Assistant 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.

**Shigo, Alex L.**

Adjunct Professor of Plant Pathology; Ph.D., West Virginia University, 1959; appointed 1967.

**Shor, Ronald E.**

Professor of Psychology; Ph.D., Brandeis University, 1960; appointed 1967.

**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.**

Assistant 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**

Assistant 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.

**Slater, Steven M.**

Assistant Professor of Chemical Engineering; Sc.D., Massachusetts Institute of Technology, 1973; appointed 1972.

**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, 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.**

Assistant 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 1970.

**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; M.A., Harvard University, 1950; appointed 1938-39, 1941.

**Stewart, James A.**

Assistant 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.

**Tattar, Terry A.**

Adjunct Assistant Professor of Plant Pathology; Ph.D., University of New Hampshire, 1971; appointed 1972.

**Teeri, Arthur E.**

Professor of Biochemistry; Ph.D., Rutgers University, 1943; appointed 1938-40, 1943.

**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.

**Torrest, Robert S.**

Assistant Professor of Chemical Engineering; Ph.D., University of Minnesota, 1967; appointed 1971.

**Trout, Ben T.**

Assistant Professor of Political Science; Ph.D., University of Indiana, 1972; appointed 1969.

**Uebel, J. John**

Associate Professor of Chemistry; Ph.D., University of Illinois, 1964; appointed 1964.

**Ulrich, Gail D.**

Assistant 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**

Assistant 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; A.M., University of Michigan, 1957; 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 1953.

**Wang, Tung-Ming**

Associate Professor of Civil Engineering; Ph.D., Northwestern University, 1960; appointed 1961.

**Warren, Jerry A.**

Associate Professor of Plant Science; Ph.D., Cornell University, 1960; appointed 1971.

**Watson, Robert I.**

Professor of Psychology; Ph.D., Columbia University, 1938; appointed 1967.

**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 1964.

**Wheeler, Charles M., Jr.**

Associate Professor of Chemistry; Ph.D., West Virginia University, 1951; appointed 1950.

**Wheeler, Douglas L.**

Associate 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.

**Wilcox, Donald J.**

Associate Professor of History; Ph.D., Harvard University, 1967; appointed 1970.

**Williams, Daniel C.**

Assistant 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.

**Winn, Alden L.**

Professor of Electrical Engineering; S.M., Massachusetts Institute of Technology, 1948; appointed 1948.

**Woodruff, John H.**

Associate Professor of Political Science; Ph.D., Boston University, 1961; appointed 1966.

**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.

**Wrightsmen, Dwayne E.**

Professor of Finance; Ph.D., Michigan State University, 1964; appointed 1964.

**Wurzburg, Frederic W.**

Associate Professor of Political Science; Ph.D., Columbia University, 1961; appointed 1963.

**Yen, Yin-Chao**

Visiting Professor of Chemical Engineering; Ph.D., Northwestern University, 1960; appointed 1965.

**Yildiz, Asim**

Professor of Mechanics; D.Eng., Yale University, 1960; appointed 1967.

**Yount, John A.**

Associate 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, 1968; appointed 1970.

# Rules Governing Residency

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## I. Basic Rule

All students attending any division of the University of New Hampshire in any capacity shall be charged tuition at a rate to be determined by their domicile. Those domiciled within the State of New Hampshire shall pay the in-state rate. Those domiciled elsewhere shall pay the out-of-state rate.

## II. Determination of Tuition Rates

**A. In-State:** The Board of Trustees shall fix the in-state tuition rate annually on the basis of their projected budget including as part of said budget the applicable funds made available by the Legislature in its biennial budget.

**B. Out-of-State:** In accordance with the policy established by the Legislative Budget Act, the out-of-state tuition rate shall be set annually by the Board of Trustees at a figure which reflects actual cost of per capita operating costs, including instructional expenses, overhead, and bond retirement (excluding self-liquidating bonds), as determined by the costs in the fiscal year just preceding the first of January for the fiscal year in which tuition is to be charged, all in accordance with the established accounting practices of the University.

## III. Determination of Student Status

A student shall be classified as in-state or out-of-state for tuition purposes at the time of his first admission to the University. The decision shall be made by the director of admissions of the appropriate division in the first instance based upon information furnished by the student's application and other relevant information available to the director.

## IV. Review of Student Status

Any student who is aggrieved by the decision of the director of admissions classifying him as an out-of-state student for tuition purposes may appeal to the Appeals Committee of the appropriate division on forms and in accordance with the procedures which shall be made available to the students in the office of the director of admissions. The student shall have the right to present to the Appeals Committee such additional evidence as he may deem appropriate in processing his appeal, and shall have the right to appear in person and be heard.

The decision of the Appeals Committee shall be final unless the Board of Trustees in its discretion elects to review the record before the Committee. No evidence may be adduced or presented before the full Board of Trustees, but review shall be of the record only.

## V. Change in Status

Any student who has, on his first admission to the University, been classified as out-of-state for tuition purposes, may apply to the director of admissions for a change of status on or before September 1 of any year for the fall semester, and on or before January 1 of any year for the spring semester. Applications shall be considered in the chronological order in which they are presented. No changes approved during a semester shall be effective until the beginning of the next following semester. Provided, however, that where a change of status from out-of-state to in-state has been denied by the director of admissions prior to the commencement of a semester, and his decision is reversed by the Appeals Committee or the Board of Trustees during the semester, the student's status shall be effective as of the commencement of the semester.

In the event the director of admissions possesses facts or information indicating that a student's status should be changed from in-state to out-of-state, the student shall be informed in writing of the change of status. The

student may appeal the decision of the director as hereinabove set forth. No such change made by the director after the commencement of any semester shall be effective until the beginning of the next semester. Change of out-of-state status made by the director prior to the commencement of any semester, but reversed during the semester by the Board of Appeals, shall be effective as of the commencement of the semester.

## VI. Application Forms

Each applicant for in-state status for tuition purposes shall submit an application on forms to be prescribed by the director of admissions which shall include a sworn statement certifying that the applicant is legally domiciled within the State of New Hampshire. The application shall also include such additional information as the director may require in support of the affidavit of domicile. In his discretion, the director may require resubmission of an application form from any in-state student prior to the commencement of each semester the student plans to attend the University.

## VII. Substantive Rules

In all cases of application for in-state status for tuition purposes, the burden of proof shall be on the applicant. At the applicant's request, the director of admissions shall state the reason or reasons for his decision in writing.

**For the purposes of determining tuition status, the following definitions and rules shall prevail:**

A. The term "parent" shall mean a person's father; or if he has no father, his mother; or if one parent has custody of an unemancipated person, the parent having custody; or if there is a guardian or legal custodian, provided that there are no circumstances indicating that such guardianship or custodianship was created primarily for the purpose of conferring the status of an in-state student on such unemancipated person.



B. No person shall be eligible for in-state tuition status unless he shall have been domiciled within the state continuously for a period of at least six months immediately prior to registration for the term for which in-state status is claimed.

C. No unemancipated person shall be eligible for in-state tuition status unless his parent shall have established domicile in this state.

D. No person shall be eligible for in-state tuition status unless he establishes that his residence in New Hampshire is for some purpose other than the temporary or primary one of obtaining an education.

E. "Domicile" denotes a person's true, fixed, and permanent home and place of habitation. It is the place where he intends to remain and to which he expects to return when he leaves without intending to establish a new domicile elsewhere.

All evidence relevant to determining domicile may be considered, but the following indicia shall, in any cases, be relevant, without limiting in any way such other information as the applicant may wish to submit or the director may wish to require:

- i. Payment or non-payment of any tax levied by the state or any political subdivision on persons resident or domiciled thereon.
- ii. Residence reported on any federal or state tax return.
- iii. Registration of one's automobile.
- iv. State issuing one's driver's license.
- v. Receipt of support in whole or in part from parents who are resident or domiciled outside the State of New Hampshire.
- vi. Voting residence.
- vii. Claim by any non-resident parent that the applicant is a dependent for tax or any other financial purpose.
- viii. Regular departure by an applicant from the State of New Hampshire during recesses or vacations from the University.

ix. The filing of any claim for benefits under any policy of insurance or any federal, state, or local benefit legislation based on residence or domicile outside the State of New Hampshire.

x. Status in some other state which would qualify a person for in-state tuition in that state.

F. Unless the contrary appears to the satisfaction of the director of admissions in individual cases, the following presumptions shall prevail:

- i. The domicile of an unemancipated person is that of his parents, or if his parents are separated or divorced, that of the parent who has custody of him.
- ii. The domicile of an unemancipated person who has no parents is that of his guardian or other legal custodian, unless it appears that such guardianship or custodianship was created for the purpose of establishing an in-state status.
- iii. The domicile of any person who first enters the University from the domicile of his parent, as defined in subparagraph A above, is that of his parent until he abandons such domicile, and, for purposes other than that of his education, acquires a new domicile.
- iv. The domicile of any person who first enters the University from a domicile other than New Hampshire is such a domicile until he abandons such domicile and, for purposes other than that of his education, acquires a new domicile.
- v. Attendance at the University or at any other educational institution in this state in itself shall not be evidence of intention to establish or establishment of a domicile in this state.

G. No person shall be deemed to be emancipated unless his parent, as defined in subparagraph A above, has entirely surrendered the right to the care, custody and earnings of such person and unless his parent is no longer under any legal obligation to support or maintain such person or, having supported and maintained such person even though under no legal obligation to do so, has ceased to support or maintain such person. Emancipation shall not be found unless all such tests are met. The following shall be indicia of emancipation, but shall not be exclusive, and other evidence may be submitted by an applicant and demanded by the director of admissions:

- i. Lack of financial support of the person by the parent.
- ii. Lack of contribution to the parent of any earnings or other income received by the person.
- iii. Failure of the parent to claim the person as a dependent on his income or other tax returns.
- iv. Establishment by the person of a domicile separate and apart from that of the parent.
- v. Failure of the person to return to the home of the parent during vacations and other recesses from school.

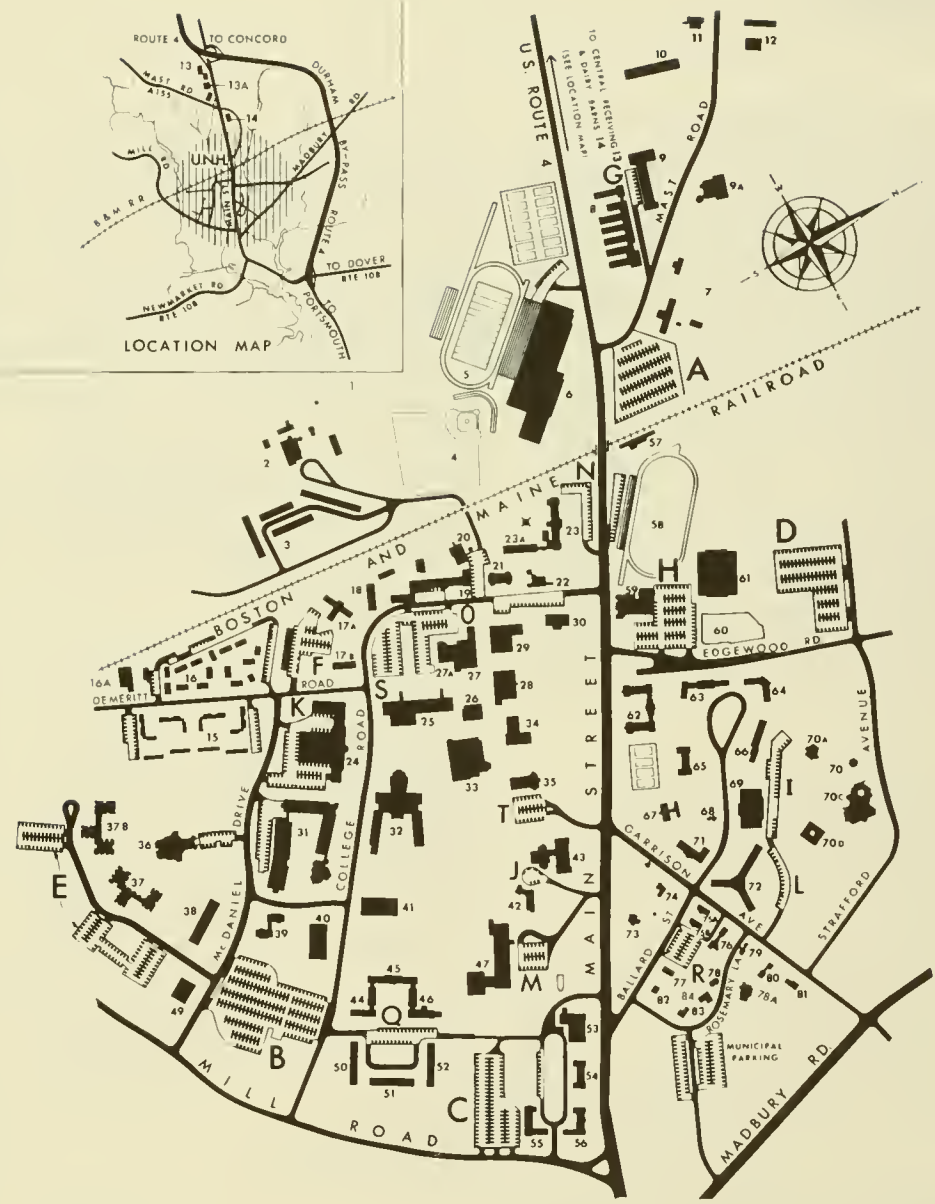
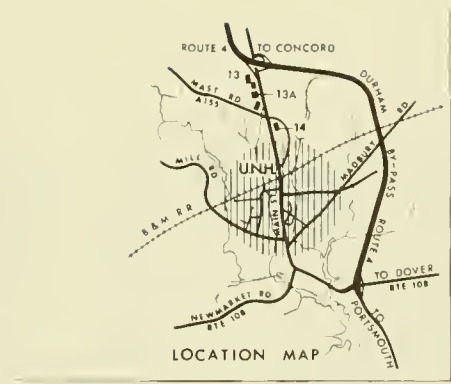
#### **VIII. Waiver**

Nothing contained in these rules shall preclude the director from waiving any requirement hereof under special circumstances in individual cases.

**Approved by University of New Hampshire Board of Trustees, January 20, 1973.**

# Campus Map and Key

Adams Residential Tower (N.E. Center)	70a	Greenhouses	8	O'Connell House	84
Admissions Office	35	Hamilton Smith Hall	43	Ombudsman	43
Agricultural Experiment Station	22	Health Studies, School of	27	Palmer House	78a
Agronomy Field Station	11	Hennessy Theater	32	Parsons Hall	31
Alexander Hall	55	Hersey House	75b	Paul Creative Arts Center	32
Alumni House	74	Hetzel Hall	56	Pettee Hall	21
Analytical Services Laboratory	23	Hewitt Hall	27	Philbrook Dining Hall	36
Babcock House	39	Hitchcock Hall	44	Poultry Plant	3
Barton Hall	9a	Hood House Infirmary	42	President's Office	35
Batcheller House	78	Horse Barn	10	Provost's Office	35
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Brackett Field	4	Huddleston Hall	53	Putnam Hall	9
Brook House	79	Hunter Hall	51	Randall Hall	45
Business Office	35	International House	80	Registrar, Registration & Records	35
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Christensen Hall	37	Janetos House	83	Richards House	77
College Woods	1	Jessie Doe Hall	66	Ritzman Nutrition Laboratory	2
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Engelhardt Hall	52	Natural & Environmental Resources, Institute of	21	Thompson Hall	35
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UNIVERSITY OF NEW HAMPSHIRE  
 DURHAM NEW HAMPSHIRE

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**This Catalog is produced by the Graduate School and the Office of Publications.**

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# Graduate School Calendar 1974-75

## Semester I



September 1, Sunday  
September 3, Tuesday  
September 4, Wednesday  
September 5, Thursday  
September 20, Friday  
September 25, Wednesday  
September 27, Friday  
October 3, Thursday  
October 19, Saturday  
October 26, Saturday  
October 29, Tuesday

November 22, Friday

November 26, Tuesday  
December 2, Monday  
December 6, Friday

December 12-13,  
Thursday-Friday  
December 16, Monday  
December 21, Saturday  
December 22, Sunday

8 a.m. Residence halls open  
Registration; 4 p.m. First faculty meeting  
8 a.m. Classes begin  
1 p.m. Opening convocation  
Last day to drop courses without \$10 late drop fee  
4 p.m. First graduate faculty meeting  
Last day to add courses  
Last day to obtain partial tuition refund on withdrawal  
Classes hold Thursday schedule  
Classes hold Friday schedule  
Mid-semester, last day to drop courses or withdraw without academic liability  
Last day for presenting dissertation or thesis at Graduate School Office for January graduation  
7 p.m. Thanksgiving recess begins  
8 a.m. Classes resume; pre-registration Semester II begins  
Last day for Ph.D. oral examination if degree candidate in December  
Reading days

8 a.m. Semester I final exams begin  
6 p.m. Final exams end  
Commencement

## Semester II



January 19, Sunday  
January 20, Monday  
January 31, Friday  
February 7, Friday  
February 18, Tuesday  
March 7, Friday  
March 17, Monday  
March 21, Friday

April 7, Monday  
April 18, Friday

May 2, Friday

May 5-6, Monday-Tuesday  
May 7, Wednesday  
May 16, Friday  
May 18, Sunday

Registration  
8 a.m. Classes begin  
Last day to drop courses without \$10 late drop fee  
Last day to add courses  
Last day to obtain partial tuition refund on withdrawal  
7 p.m. Spring recess begins  
8 a.m. Classes resume  
Mid-semester, last day to drop courses or withdraw without academic liability  
8 a.m. Pre-registration for Semester I 1975-76 begins  
Last day for presenting dissertation or thesis at Graduate School Office for June graduation  
Last day for final Ph.D. oral examination if degree candidate in June  
Reading days  
8 a.m. Semester II final exams begin  
Final exams end  
Commencement



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