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1968-69



The University of New Hampshire

# The Graduate School 1968-69

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# University Calendar 1968-69

## Summer Session 1968

June 24, Monday	Registration, eight-week session and first four-week session
June 25, Tuesday	First day of classes
July 8, Monday	Registration, six-week session
July 9, Tuesday	First day of classes
July 19, Friday	Last day of first four-week session
July 22, Monday	Registration and first day of classes, second four-week session
August 16, Friday	Classes end

## Semester I

September 15, Sunday	Residence halls open
September 16, Monday	First Faculty meeting
September 17, Tuesday	Registration
September 18, Wednesday	Classes begin, abbreviated schedule
September 27, Friday	4:30 P.M., Last day to add courses
November 11, Monday	4:30 P.M., Last day to drop courses
November 26, Tuesday	7:00 P.M., Thanksgiving recess begins
December 2, Monday	8:00 A.M., Classes resume
December 18, Wednesday	7:00 P.M., Christmas recess begins
January 6, Monday	8:00 A.M., Classes resume
January 20, Monday	Semester I final examinations begin
January 29, Wednesday	6:00 P.M., Final examinations end

## Semester II

February 7, Friday	Registration
February 10, Monday	8:00 A.M., Classes resume
February 17, Monday	4:30 P.M., Last day to add courses
April 4, Friday	7:00 P.M., Easter recess begins
April 14, Monday	8:00 A.M., Classes resume
April 14, Monday	Last day for filing application for 1969 Summer Session graduate scholarships
April 14, Monday	4:30 P.M., Last day to drop courses
May 16, Friday	Last day for presenting Ph.D. dissertations at Graduate School office if degree candidate in June
May 23, Friday	Last day of classes
May 23, Friday	Last day for final Ph.D. oral exam if degree is to be granted in June
May 26, Monday	8:00 A.M., Semester II final examinations begin
May 30, Friday	Memorial Day, holiday
May 31, Saturday	Semester II examinations continue
June 5, Thursday	6:00 P.M., Final examinations end
June 8, Sunday	Commencement





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- Marc L. Schwarz, A.M.T., Ph.D.**  
Assistant Professor of History
- Ronald E. Shor, M.S., Ph.D.**  
Associate Professor of Psychology
- Samuel D. Shore, M.A., Ph.D.**  
Assistant Professor of Mathematics
- Ralph E. Sibley, A.B., Ph.D.**  
Assistant Professor of Psychology
- Robert J. Silverman, M.S., Ph.D.**  
Professor of Mathematics
- Robert E. Simpson, M.A., Ph.D.**  
Assistant Professor of Physics
- Winthrop C. Skoglund, M.S., Ph.D.**  
Professor of Poultry Science
- H. Richard Skutt, M.S., Ph.D.**  
Associate Professor of Electrical Engineering
- Lawrence W. Slanetz, Ph.D.**  
Professor of Microbiology
- Roger P. Sloan, M.P.A.**  
Assistant Professor of Forest Resources
- Gerald L. Smith, M.S.**  
Associate Professor of Animal Science
- M. Daniel Smith, Ed.M., Ed.D.**  
Associate Professor of Education
- Philip M. Smith, M.Ed.**  
Assistant Professor of Education
- Samuel C. Smith, M.S., Ph.D.**  
Associate Professor of Biochemistry and Poultry Science
- James L. Spangenberg, Ph.D.**  
Associate Professor of Home Economics
- Donald Steele, M.A.**  
Professor of Music
- Glenn W. Stewart, M.A.**  
Associate Professor of Geology
- Samuel E. Stokes, Jr., M.A., Ph.D.**  
Associate Professor of French
- E. Howard Stolworthy, B.S.**  
Professor of Mechanical Engineering
- Deborah E. Stone, Ed.M.**  
Assistant Professor of Education
- Kerwin C. Stotz, M.S., Ph.D.**  
Associate Professor of Electrical Engineering
- Richard G. Strout, M.S., Ph.D.**  
Associate Professor of Poultry Science
- Margaret S. Sullivan, A.B.**  
Assistant Professor of French
- Emery F. Swan, Ph.D.**  
Professor of Zoology
- Arthur E. Teeri, M.S., Ph.D.**  
Professor of Biochemistry
- Edward K. Tillinghast, Ph.D.**  
Assistant Professor of Zoology
- Herbert Tischler, M.A., Ph.D.**  
Professor of Geology
- Jacob J. Uebel, M.S., Ph.D.**  
Assistant Professor of Chemistry
- Dale S. Underwood, M.A., Ph.D.**  
Professor of English
- Willard E. Urban, Jr., M.S., Ph.D.**  
Assistant Professor, Agricultural Experiment Station
- Russell Valentine, M.S.**  
Associate Professor of Mechanical Engineering
- Meenahshisunder Venkatesan, M.S., Ph.D.**  
Assistant Professor of Business Administration
- Donald Vincent, A.M.L.S.**  
University Librarian
- Robert P. Vreeland, M.S., M.Eng.**  
Associate Professor Civil Engineering
- Oliver P. Wallace, Sr., M.F., Ph.D.**  
Associate Professor of Forest Resources
- Tung-Ming Wang, M.S., Ph.D.**  
Associate Professor Civil Engineering
- Peter Waring, M.A., S.M.D.**  
Associate Professor of Music
- Robert J. Watson, Ph.D.**  
Professor of Psychology
- Wayne D. Webb, M.A., Ph.D.**  
Associate Professor of Education
- James Harold Weber, Ph.D.**  
Assistant Professor of Chemistry
- Laurance Webber, M.S.**  
Director, Engineering Experiment Station
- Robert G. Webster, M.A.**  
Professor of English
- Otho S. Wells, M.S., Ph.D.**  
Assistant Professor of Plant Science



**William Wetzel, M.B.A., Ph.D.**

Assistant Professor of Business  
Administration

**Richard R. Weyrick, M.F.**

Assistant Professor of Forest Resources

**Charles M. Wheeler, Jr., M.S., Ph.D.**

Associate Professor of Chemistry

**Douglas L. Wheeler, A.M., Ph.D.**

Assistant Professor of History

**John B. Whitlock, M.A., Ph.D.**

Associate Professor of Music

**John D. Wicks, M.A., Ph.D.**

Associate Professor of Music

**Thomas A. Williams, Jr., M.A.**

Associate Professor of English

**Robin D. Willits, Ph.D.**

Associate Professor of Business  
Administration

**Alden L. Winn, M.S.**

Professor of Electrical Engineering

**Christopher C. White, M.A., Ph.D.**

Assistant Professor of Mathematics

**William G. Witthoft, S.M., Ph.D.**

Assistant Professor of Mathematics

**John Woodruff, M.A., Ph.D.**

Associate Professor of Political Science

**Paul A. Wright, M.A., Ph.D.**

Professor of Zoology

**Dwayne Wrightsmann, M.B.A., Ph.D.**

Assistant Professor of Finance

**Frederic W. Wurzburg, Ph.D.**

Associate Professor of Political Science

**Marjory Wybourn, M.A., Ed.D.**

Professor of Home Economics

**W. Tseng Yang, M.S., Ph.D.**

Assistant Professor of Mechanical  
Engineering

**Yin-Chao Yen, M.S., Ph.D.**

Adjunct Professor of Chemical  
Engineering

**O. T. Zimmerman, M.S.E., Ph.D.**

Professor of Chemical Engineering

**J. Harold Zoller, Ph.D.**

Professor of Civil Engineering

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## Committees

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### Graduate Council

**John W. McConnell, Ph.D.**

President of the University

**H. Trevor Colbourn, Ph.D.**

Dean of the Graduate School, *Chairman*

**William H. Drew, Ph.D.**

Associate Dean of the Graduate School

**Alexander R. Amell, Ph.D.**

Professor of Chemistry

**Thomas A. Carnicelli, Ph.D.**

Assistant Professor of English

**Robert W. Corell, Ph.D.**

Professor of Mechanical Engineering

**Miyoshi Ikawa, Ph.D.**

Professor of Biochemistry

**Roland B. Kimball, Ed.D.**

Professor of Education

**Charles H. Leighton, Ph.D.**

Associate Professor of Spanish

**M. Evans Munroe, Ph.D.**

Professor of Mathematics

**Sam Rosen, Ph.D.**

Professor of Economics

**Samuel C. Smith, Ph.D.**

Associate Professor of Biochemistry and  
Poultry Science

**Robert I. Watson, Ph.D.**

Professor of Psychology

**Paul A. Wright, Ph.D.**

Professor of Zoology

### Graduate Scholarships

**John J. Sasner, Ph.D.**

Assistant Professor of Zoology, *Chairman*

**Douglas M. Norris, Ph.D.**

Associate Professor of Mechanical  
Engineering

**Dwayne Wrightsmann, Ph.D.**

Assistant Professor of Finance

**Gerald L. Klippenstein, Ph.D.**

Assistant Professor of Biochemistry



# Regulations of the Graduate School

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## General Information

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The Graduate School, which has offered instruction since 1903, has for its objective the bringing together of faculty and qualified students in a spirit of scholarship and research. The graduate student is given opportunity to specialize in some field of knowledge, and to develop a maturity of thought and attitude toward his professional field, so that both his professional and his cultural life are enhanced.

The work of the Graduate School is under the general direction of the Graduate Faculty. The Dean of the Graduate School is responsible for the administration of the regulations and requirements pertaining to admission, conduct of work, the granting of advanced degrees, and other pertinent matters.

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## General Regulations

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### Admission

Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided their undergraduate records are satisfactory. Before entering upon graduate work the applicant must present evidence that he has had the necessary prerequisite training which will enable him to pursue the courses desired. A candidate for admission must have a superior

undergraduate record. Where the department in which the candidate plans to do his work so requires, the candidate may be required to take an achievement test. In addition there may be special requirements set up by individual departments or programs. For the individual departmental requirements, see the description under the departmental offerings in this catalog.

A student who desires to register for graduate study must submit to the Dean of the Graduate School the official application for admission to graduate study. Forms for this purpose may be obtained by writing to the Dean of the Graduate School, University of New Hampshire, Durham, New Hampshire 03824. The application must be accompanied by two official transcripts of the student's undergraduate work and of any previous graduate work, and by three letters of reference. Transcripts of applicants who are admitted to graduate study become a permanent part of the University files and will not be returned.

Applications to the University of New Hampshire Graduate School submitted on or after September 1, 1968, must be accompanied by a non-refundable \$10 application fee.

Students wishing to enroll in the Master of Science for Teachers program must meet one of the following admission requirements: (a) Education courses sufficient for certification, (b) three years' experience in teaching, or (c) current full-time participation in teaching.

Completed applications for admission to the Graduate School should be submitted before July 15 for the first semester, before November 15 for the second semester, and before April 1 for the Summer Session to guarantee action before the respective registration days. Applications will be accepted after the dates mentioned above, provided that the applications are accompanied by complete official transcripts; but it may be necessary in such instances to postpone the evaluation of credentials and the determination of requirements until after the registration period. Students wishing to apply for financial aid must submit their applications for admission prior to February 15.

Foreign students applying for admission to the Graduate School must furnish proof of their ability to handle the English language. Such students should take the "Test of English as a Foreign Language" administered by the Educational Testing Service, Princeton, New Jersey. All regularly enrolled graduate students must have a medical history and physical examination report on file with the Director of the University Health Service. Recent graduates of the University of New Hampshire need not file a new set of reports upon being admitted to the Graduate School. Others should obtain the proper forms from the Dean of the Graduate School.

Admission to the Graduate School does not imply admission to candidacy for a degree. No graduate student is admitted to candidacy for a degree until he has been in residence a sufficient length of time to enable his instructors to judge his ability to carry on graduate work. Generally this period of time shall be not less than that required for the completion of 12 credits of graduate work for the Master's degree, and the passing of the qualifying examination and the completion of departmental language requirements for the Ph.D. degree. Admission to candidacy for a degree will be determined by the Dean upon the recommendation of the department concerned.

The student will be notified by the Dean, in writing, of the decision made.

A student admitted to graduate study must have his program approved by the chairman of his department or of his guidance committee and the Dean of the Graduate School. Registration is held prior to the beginning of classes each semester and on the first day of Summer Session. Consult the calendar in this catalog for the dates of registration.

Graduate students are defined as those who meet the requirements for admission to the Graduate School and are registered for an approved program for graduate credit.

The maximum graduate load allowed is 16 semester credits for a regular semester, seven credits for a six-week Summer Session, and nine credits for an eight-week Summer Session. Only under unusual circumstances will excess credits be allowed, and then only with the approval of the Dean of the Graduate School.

### Graduate Credits

Graduate credits may be earned only in courses numbered from 700 through 898, and in the thesis, but graduate credits will not be given in any courses so numbered which are open to freshmen or sophomores. For certain cases graduate credit is allowed for 600 level courses for Master's degree programs.

Graduate students who desire to do a part of their work during the Summer Session of the University will find graduate courses offered in many departments. Credit in appropriate courses may be used in fulfilling the requirements for an advanced degree. For complete information on the Summer Session, see the Summer Session catalog.

Qualified senior students in the University of New Hampshire may be admitted to the Graduate School, and must have been admitted before taking courses for graduate credit.

Students holding the baccalaureate degree who have not been admitted to the Graduate School, but who wish to reg-

ister for graduate courses, must receive the approval of the Dean of the Graduate School and of the instructor concerned.

An incomplete grade in the Graduate School must be made up within a year after the course was to have been completed. This rule does not apply to the completion of the thesis.

The student must meet the special requirements of the department in which he is doing his graduate work and his program must be approved by his adviser and the Dean of the Graduate School. For these special requirements see the department statements in this catalog.

### Graduate Grades

The three passing grades are: Honors (H), High Pass (HP), and Pass (P). A graduate student receiving nine or more credits with a failing grade (F) will normally be required to withdraw from the Graduate School. Students enrolled in Master's programs requiring in excess of thirty credits will be permitted a proportional increase in the amount of failing work. A grade of Cr (Credit) is given for completed theses and dissertations.

### Tuition

The tuition is \$630 a year for residents of New Hampshire and \$1,500 a year for non-residents. Tuition rates in the Summer Session and for courses offered by the University Extension Service are listed in their respective catalogs. It should be noted that liberal financial aid is available to graduate students.

Any student registering for eight credits or more per semester will pay the full semester tuition. Any student registering for fewer than eight credits per semester shall pay \$25.00 per credit hour. Graduate assistants may be exempted from payment of tuition.

A doctoral student who is registered for fewer than eight credits and is pursuing research for the dissertation shall pay

by the credit hour, plus a research charge of \$50 a semester. If registered for research only, the charge of \$50 a semester will be applicable and will carry with it the privilege of attending seminars.

When a doctoral candidate completes his requirements *in absentia*, a charge of \$50 for the privilege of taking the final examination must be paid six weeks before the conferring of the degree.

A Memorial Union assessment of \$6.00 per semester must be paid by each student.

The immediate families of members of the University staff may register as full or part-time students in the Graduate School at one-half the current tuition or course rate. They are required, however, to pay the full research fee, if doctoral students.

The University reserves the right to adjust charges for such items as tuition, board, and room rent from time to time. Such changes will be held to a minimum and will be announced as far in advance as feasible.

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## Assistantships, Scholarships, and Fellowships

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Approximately 175 graduate assistantships are available each year. Such assistantships are awarded only to superior students. The re-appointment of a graduate assistant is contingent on the maintenance of a high level of scholarship. The service required of the graduate assistant may be in the nature of teaching assistance, research assistance, or general service.

There are two categories of regular assistantships available. The recommended conditions of employment for each category are as follows:

1. \$2,400 for the academic year for an approved schedule of part-time services to the department, normal academic program: 9 semester hours per semester.

Exemption from payment of tuition may be granted for the academic year and the following Summer Session on recommendation of the department chairman. 2. \$3,360 (10 months at \$240, 2 months at \$480) for the fiscal year for part-time service during the academic year, and full-time during the summer with one month vacation. Normal academic program: 9 semester hours per semester. Exemption from payment of tuition for the regular academic year may be granted on the recommendation of the department chairman.

Inquiries regarding assistantships should be addressed to the chairman of the department concerned.

Scholarships and fellowships ranging in value from remission of tuition to over \$5,000 per year are available to qualified graduate students.

Up to fifty superior students may be granted tuition scholarships. These awards are subject to the maintenance of a high scholastic record in the Graduate School and may be revoked at the end of any semester if the student does not merit such an award. Foreign students will be considered for scholarship awards.

Up to thirty superior students, who have been regularly admitted to the Graduate School, may be granted exemption from Summer Session tuition.

A limited number of three-year fellowships, called University of New Hampshire Fellowships, are awarded to outstanding doctoral students. Each recipient is given an opportunity to spend the first year in fulltime study, the second year as a teaching assistant, and the third year as a research assistant. The stipends for this program are \$2,400 for the first year, and \$2,600 for the second and third years respectively. In addition, the award provides \$680 of support for each of two summers, waiver of tuition, and an annual allotment of \$500 each for as many as two dependents.

A limited number of Alumni Fellowships are available to students following a graduate program in the social sciences

and humanities. The stipend is \$3,000 per academic year plus tuition waiver.

Traineeships sponsored by the National Science Foundation are available to outstanding students studying for the Master's or Ph.D. degree in the various science and engineering fields. The basic stipends (for 12 months of study) range from \$2,400-\$2,800 plus free tuition and \$500 per dependent — Open to U. S. citizens only.

National Defense Education Act (NDEA Title IV) fellowships are available to highly qualified students who are studying for the Ph.D. degree and interested in college teaching careers. Academic year stipends range from \$2,000 to \$2,400 plus free tuition and \$400 per dependent. An additional stipend of \$400 plus \$100 per dependent is available for summer study — Open to U. S. citizens only. Graduate students also are eligible for awards granted by other national agencies and foundations.

Twenty-five Summer Fellowships for Teaching are available for students who have held teaching assistantships during the previous academic year. The stipend for summer study is \$680.

Information and application forms concerning all of the above scholarship and fellowship programs may be obtained from the Dean of the Graduate School. Properly qualified scholars, who may desire temporarily the privileges of 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 possibly the cost of unusually expensive supplies or equipment.

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## Requirements for the Master's Degree

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For the degrees of Master of Arts, Master of Science, Master of Agricultural Education, Master of Business Administration, and Master of Public Administration, at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis, 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 are obtained for the Master of Science for Teachers degree and it is recommended for this degree, as well as for all other Master's degrees, 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 campus. Of these 12, only 6 may be from another graduate school.

All graduate work for any Master's degree must be completed in not more than eight years from the time of registration for the first work taken for the degree.

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 gov-

erning 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, will be 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.

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. These will be applied toward the degree only if approved by the major department and the Dean of the Graduate School.

### 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 of three, comprising the instructor under whose direction it was written and two other members of the Graduate Faculty selected by the department chairman and approved by the Dean of the Graduate School.

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

The number of thesis credits may vary from six to ten, subject to the approval of the student's adviser.

No thesis credit shall be given until the completed thesis has been approved by the committee on the thesis. 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 mimeographed regulations for the form and typing of thesis.

Whenever a thesis is printed, it must be

designed 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 turned in 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. (See departmental requirements in this catalog.)

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## Requirements for the Doctor's Degree

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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, Genetics, Mathematics, 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 may be advantageous.

### General Requirements

A student working for the Ph.D. degree must earn a passing grade in all the courses required by his guidance committee. Certain courses may be taken for audit.

When the student declares his intention to proceed to candidacy for the degree of Doctor of Philosophy, the department of intended major concentration shall notify the Dean of the Graduate School, who then, upon recommendation of the department, will appoint a guidance committee. This committee will assist the student in outlining his program and in preparing him for his qualifying examination. To prepare him for the qualifying examination and successful pursuit of his research and course work, the guidance committee may require him to take additional course work, with or without credit.

At the time of application by the student for the qualifying examination, a doctoral committee will be appointed to supervise the qualifying and final examinations and to pass on the dissertation. This committee shall 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, and the Dean of the Graduate School, *ex officio*.

The qualifying examination may be written, or oral, or both. This examination will test: (1) the student's general knowledge in his major and minor work, and (2) his 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.

The student may not be advanced to candidacy for the Ph.D. until he has passed the qualifying examination and such



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## University Services

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language requirements as are deemed desirable by the major department. The proposed subject of the student's dissertation must be declared at the time of application for advancement to candidacy. Resident full-time members of the University of New Hampshire faculty with rank of Assistant Professor or higher may not be admitted to candidacy for the Ph.D. at this University.

The dissertation must be a mature and competent piece of writing, a contribution to knowledge, embodying the results of significant and original research.

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. The 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.

The Counseling and Testing Center provides, without charge, and through a professionally qualified staff, a range of psychological services to students who are experiencing a persistent personal or emotional difficulty, or some disruption in their academic lives. The services of the office are not limited to those with severe problems, but are geared to the needs of the typical college student. Diagnostic services, with the assistance of a consulting psychiatrist, are also available to students whose needs go beyond the scope of our own facilities. In such cases, treatment planning and/or referral to outside sources are provided.

The University Health Service, located in Hood House, is devoted to the protection, improvement, and maintenance of student health. Graduate students carrying eight or more credits and graduate assistants are eligible for treatment. A well-equipped outpatient clinic for diagnosis and treatment of ambulatory patients and modern infirmary of twenty-six beds with an isolation division for communicable diseases is available for students who require inpatient care. During the regular academic year registered nurses are on duty at all times and Hood House is open twenty-four hours daily. Individual health guidance is given through personal conferences with the University physicians. Routine office hours of the University physicians are from 9:00 a.m. to 12:00 noon and 1:30 p.m. to 4:00 p.m. daily, except Saturdays and Sundays when emergency care is available.

The Health Service is closed when the University is officially closed for holidays, closing one hour after dormitories are secured, and opening at 3:00 p.m. on the day before classes resume. During the Summer Session, Hood House is open Monday through Friday, 8:00 a.m. to 4:00 p.m.

Injury and illness which require hospital

confinement, services of specialists, operations, special nurse, or special prescriptions are at the expense of the student. Bed patients at Hood House are charged \$5.00 per day.

In addition to the health service available through Hood House, group accident and sickness insurance, giving twelve-months coverage, is available to students at the University. This insurance coverage is designed to supplement the program of the University. Complete details may be had on application to the Business Office, Thompson Hall.

The Memorial Union is a campus center for outside-the-classroom activities for the University community. It provides social, recreational, and educational meeting rooms, game rooms, and meals and snacks, as well as headquarters for a number of student organizations. The Union staff reserve rooms for organizations to meet in the Memorial Union and in other University buildings and serve as a central source of campus information. A program of activities for all students is planned by the all-student board of governors of the Memorial Union Student Organization.

The Memorial Union is a gift of the citizens of New Hampshire, the students, the alumni, the faculty and staff, and other friends of the University. The building serves three principal purposes: as a living memorial to the men and women of the State of New Hampshire who have sacrificed their lives in our armed forces, as a college union, and as a state-wide conference center.

The objective of the University Placement Service is to assist students in obtaining summer and permanent employment. The office maintains contact with recruiting personnel from business, industry, government, and education, and keeps files on positions available as well as vocational information about employing organizations. Also available is vocational counseling as an adjunct to the

faculty-student guidance relationship. Students receiving degrees in February, June, or August should complete the placement registration procedure in September. Registration is important, and should be completed by the student while on campus, even though permanent employment is not sought immediately after graduation. An on-campus interview program functions between November and April. The services of University Placement are also available to alumni of the University.

Those individuals who have received an advanced degree from the University of New Hampshire automatically become members of the Alumni Association. The present membership of the Association exceeds 27,000 men and women who represent New Hampshire College and University of New Hampshire classes from 1896 through the present. Alumni reside in every state of the Union as well as in many foreign countries.

Governed by a Board of Directors of 15 elected and 4 *ex officio* members, who are the elected Alumni Trustees, the alumni are organized by classes and clubs. Class reunions are held annually. An annual Homecoming Day in the fall provides opportunity for alumni to return to Durham while the University is in session. Other alumni gatherings on campus are also scheduled from time to time during the academic year. There are 50 UNH alumni clubs throughout the United States. A bi-monthly magazine, "The New Hampshire Alumnus," circulates news of students, faculty, alumni, and the University to subscribers. From offices in Alumni House on the campus, the Association's activities are directed by a permanent Director of Alumni Affairs and his staff.

## Housing

Babcock House, completed in January, 1968, is the graduate residence center for single graduate students. Two six-story towers connected at each floor by a

lounge accommodate 180 men and women. Facilities include a large lounge with fireplace, two recreation rooms, food vending room, coin operated laundry, TV room, ski storage, luggage storage, and individual mail lock boxes. The Faculty in Residence and his family live in a two-bedroom apartment on the ground floor.

The resident rooms are all single rooms allowing complete privacy for consultation with students or faculty. Rooms are furnished with a bed, mattress, pillow, easy chair, desk chair, waste basket, and a built-in desk-dresser-wardrobe unit with book shelves, mirror, medicine chest, and desk lamp. Residents provide their own bedding. An optional linen service is available furnishing bed linen, towels, and blankets. Linen and towels are laundered weekly. The charge for this service will be \$25.00 for linen and towels or \$31.00 for linen, towels, and two blankets. Room rent is \$500.00 for the academic year.

Babcock House is located on College Road opposite Randall and Hitchcock residence halls. Parking space is available for graduate students. Although there will be no meal preparation in Babcock House, residents may elect to take a 21-meal contract at either Huddleston or Stillings dining halls, if space is available, for \$440.00 for the academic year. Students who do not wish to take the contract may buy individual meals on a cash basis.

As soon as a student is notified of his admission to the Graduate School he may request a housing application and contract. Please read carefully the housing contract because it is binding for the entire academic year beginning in September and ending in June. The contract may not be broken during the academic year. Rent is payable in advance in two equal installments of \$250.00, due by July 15 (or the date stipulated on the notice of room assignment and bill) and January 15 for the second semester

*Off-Campus Housing* — University Housing maintains a partial listing of off-

campus apartments, rooms, and houses within the immediate area of Durham. Because of the day to day changes in this list it is not feasible to send copies of it. A trip to Durham will usually prove more satisfactory. The Housing Office is open Monday through Friday, 8:00-12:00 and 1:00-4:30.

## Dining Services

The University Dining Services operates a cafeteria in the Memorial Union where meals may be obtained normally on an a la carte plan. However, during the year 1968-69 remodeling is planned at the Union and this service may have to be interrupted. When dining hall capacities permit, graduate students may also purchase a semester meal ticket which would provide twenty-one (21) meals weekly for the entire semester. Meal tickets are good only in one of the two dining halls — Stillings and Huddleston.

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## IBM Key Codes

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The following numbers are used extensively in machine-processed data to identify both undergraduate and graduate programs offered at the University. An asterisk preceding the number identifies those departments which offer graduate programs.

### College of Liberal Arts

- 40 Liberal Arts non-departmental
- \*41 Biological Sciences Division
- 42 Education Division
- 43 Humanities Division
- 44 Physical Sciences Division
- 45 Social Sciences Division
- 46 The Arts
- \*47 Microbiology
- \*48 Education
- \*49 English
  - 50 Geography
- \*51 Geology
- \*52 Government
- \*53 History
  - 54 Nursing
- 55 Foreign Language and Literature
- \*56 French
- \*57 German
  - 58 Greek
  - 59 Italian
- \*60 Latin
- 61 Russian
- \*62 Spanish
- \*63 Music

- 64 Music Education
- 65 Occupational Therapy
- 66 Philosophy
- \*67 Psychology
- \*68 Sociology
- 69 Speech and Drama
- \*70 Zoology

### College of Agriculture

- 20 Agriculture non-departmental
- \*21 Resource Economics
- \*22 Agricultural and Extension Education
- \*23 Soil and Water Science
- \*25 Animal Sciences
- \*26 Biochemistry
- \*27 Botany
- \*29 Entomology
- \*30 Forestry
- \*31 Home Economics
- \*32 Plant Sciences

### College of Technology

- 79 Technology non-departmental
- \*80 Chemical Engineering
- \*81 Chemistry
- \*82 Civil Engineering
- \*83 Electrical Engineering
- \*84 Mathematics
- \*85 Mechanical Engineering
- \*86 Physics

### Whittemore School of Business and Economics

- \*71 Business Administration
- \*72 Economics
  - 73 Secretarial Studies
  - 74 Hotel Administration

# Departmental Requirements and Description of Courses

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## Agricultural Education (22)

William H. Annis, *Program Chairman*

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The degree of Master of Agricultural Education is designed for teachers of agriculture, county Cooperative Extension Service personnel, and others in adult education.

A comprehensive examination will be required of all candidates for this degree

### 789. Seminar in Agricultural and Extension Education

Library and reference work and the preparation of papers for various phases of agricultural and extension education. Mr. Annis. Prerequisite: Supervised Practice or 6 hours in Agricultural Education. 1 credit

### (792). 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. This course is scheduled concurrently with Agricultural Education 794 and 795. Mr. Annis. Prerequisite: Agricultural Education 650 or permission of instructor. 4 credits.

### (794). Supervised Practice

Supervised practice in the specific and related problems of agricultural

education. Students will be placed in vocational agriculture centers and county Cooperative Extension Service centers. Mr. Annis. Prerequisite: Agricultural Education 650 or permission of instructor. 2-11 credits.

### 795. 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. Mr. Annis. Prerequisite: Agricultural Education 650 or permission of instructor. 3 credits.

### 796. Investigations in (a) Vocational Education, (b) Extension Education, (c) Adult Education

An opportunity is provided for a student to study a special problem in one of the areas listed. Elective only after consultation with the instructor in charge. Hours to be arranged. 1-6 credits. May be repeated.

### 797. 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 education. Open to teachers of vocational education and others by permission of instructor. 3 credits.

**798. Supervision and Administration of Vocational Education**

The federal and state requirements for vocational education programs in the secondary schools. 2-3 credits.

**799. History and Philosophy of Vocational Education**

The development of vocational education in the United States with emphasis on the socio-economic influences responsible for its establishment. Its relationship with general education, together with the coordination of instructional programs in the various vocational fields. 2-3 credits.

**801. Advanced Methods in Agricultural Mechanics Instruction**

Agricultural mechanics problems and how to approach them in the high school as a part of the course of study in vocational agriculture. The physical setup, as well as the processing of supplies and equipment, methods of supervision and direction of agricultural mechanics projects, and the preparation and presentation of demonstrations. Mr. Gilman. 2 credits. (Offered in 1968.)

**802. Methods in Teaching the Operation and Maintenance of Farm Tractors**

Methods of teaching the servicing and maintenance of the various mechanical systems found on farm tractors. Teaching plans, techniques of instruction, and essential skills. Demonstrations, discussions, and laboratory participation will make up a considerable part of the class work. Mr. Gilman. 2 credits.

**803. Methods in Teaching the Care and Maintenance of Agricultural Machinery**

Content includes, in addition to methods in teaching, teaching plans, techniques of instruction, and the essential skills. Demonstrations, discussions, and laboratory participation will make up the balance of the work. Mr. Gilman. 2 credits.

**804. Program Planning in Agricultural Education**

The basic problems, principles, and procedures in the process of program planning in vocational agriculture and extension. Mr. Annis. 2 credits. (Offered in 1968.)

**805. Planned Agricultural Experience Programs in Vocational Agriculture**

Development of cooperative relations, selection and development of individual programs with the students, and the supervision and evaluation of such programs. Mr. Annis. 2 credits. (Offered in 1970.)

**806. Preparation and Use of Visual Aids for Agricultural Education**

The purpose of visual aids and the kinds best adapted to use in the program, together with their preparation and use. 2 credits. (Offered in 1969.)

**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. 2 credits. (Offered in 1970.)

**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. 2 credits. (Offered in 1968.)

**895, 896, 897. Investigations in Agricultural Education**

Individual study problems in various phases of agricultural education. Prerequisite: Permission of staff. 2 credits.

**899. Master of Agricultural Education Thesis**  
6-10 credits.

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## **Animal Sciences (25)**

(Dairy, Livestock, Poultry)  
W. C. Skoglund, *Chairman*

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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. A thesis is required and a candidate for the Master's degree shall pass an oral examination covering his graduate courses and thesis.

### **703. Animal Genetics**

Mendelian and quantitative inheritance in animals. Principles and systems of selection. Mr. Collins. Prerequisite: 3 credits of genetics or permission of instructor. 2 lectures 1 laboratory; 3 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.

### **708. Advanced Dairy Science**

Basic data, fundamental observations, and discussions of research contributing to the present status of the dairy industry. Mr. Moore. Prerequisite: Adequate preparation in chemistry and bacteriology. 2 credits.

### **710. Dairy Cattle Nutrition and Management**

Basic ruminant nutrition and feeding management, including the feeding of young ruminants, with the objective of economical milk production. Mr. Holter. 2 lectures; 1 laboratory; 3 credits.

### **711-712. Investigations in Dairy, Livestock, Poultry**

#### **1. Genetics**

Mr. Gerald Smith, Mr. Collins, Mr. Boynton.

#### **2. Nutrition**

Mr. Gerald Smith, Mr. Ringrose, Mr. Colovos, Mr. Holter, Mr. Riker.

#### **3. Management**

Mr. Skoglund, Mr. Gerald Smith, Mr. Boynton.

#### **4. Diseases**

Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. Samuel Smith.

#### **5. Products**

Mr. Gerald Smith, Mr. Moore.

#### **6. Light Horsemanship**

Mrs. Briggs, Mr. Riker.

#### **7. Physiology**

Mr. Fowler, Mr. Riker.

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. 1-3 credits. May be repeated.

### 801. Advanced Animal Breeding

Practical breeding problems with beef and dual-purpose cattle, sheep, horses, and hogs. The genetic principles important to successful livestock production. Mr. Gerald Smith. 2 lectures; 1 laboratory; 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. 2 lectures; 1 laboratory; 3 credits.

### 803. Advanced Animal Nutrition

Incidental lectures, assigned reading, and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Colovos. 3 credits.

### 804. Advanced Dairy Cattle Breeding

The analysis and formulating of breeding programs, principles of milk secretion, and factors influencing the quantity and quality of milk. Mr. Boynton. 2 lectures; 1 laboratory; 3 credits.

### 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.

### 809-810. 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.

### 812. Quantitative Genetics and Animal Improvement

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prerequisite: 3 credits each in genetics and statistics. 3 lectures; 3 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.

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## Biochemistry (26)

Edward J. Herbst, *Chairman*

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Students admitted to graduate study in the Department of Biochemistry should have completed basic courses in chemistry, biological sciences, mathematics, and physics. The candidate for the Master of Science degree will be required to prepare a thesis, and to pass an oral examination on the thesis and on graduate courses prescribed for the degree program.

The Doctor of Philosophy degree candidate will be required to complete a dissertation on original research in biochemistry and to pass examinations supervised by the Doctoral Committee. Each candidate will be expected to demonstrate a broad basic knowledge of the field of biochemistry and to pass



reading proficiency examinations based on the biochemical literature in two foreign languages, usually German and French.

#### **751. Principles of Biochemistry**

The fundamental principles of biochemistry with emphasis on the chemical properties, metabolic pathways, and functions of carbohydrates, lipids, and nitrogenous compounds. Mr. Herbst and Mr. Ikawa. Prerequisite: satisfactory preparation in organic chemistry and quantitative analysis. 3 lectures; 2 laboratories; 5 credits.

#### **756. 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; 2 laboratories; 5 credits.

#### **762. Plant Metabolism**

The function, occurrence, synthesis, and degradation of plant constituents. Major emphasis will be placed on respiration and photosynthesis and their relationship to the metabolism of lipids and nitrogen compounds. Mr. Routley. Prerequisite: Biochemistry 751 or 756 or equivalent. 2 lectures; 1 laboratory; 3 credits.

#### **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 756 or permission of instructor. 2 lectures; 2 credits.

#### **772. Biochemical Genetics Laboratory**

Experimental techniques applicable to the study of genetics at the biochemical level. To be taken in conjunction with

Biochemistry 770. 2 laboratories; 2 credits.

#### **811. Biochemistry of Lipids**

The chemistry, metabolism, and function of lipids. Mr. Smith. Prerequisite: general biochemistry. 2 credits.

#### **821. Biochemistry of Amino Acids**

The chemistry, metabolism, and function of amino acids and related substances. Mr. Teeri. Prerequisite: general biochemistry. 2 credits.

#### **832. Biochemistry of Carbohydrates**

The chemistry, metabolism and function of carbohydrates and related substances with emphasis on the polysaccharides. Mr. Ikawa. Prerequisite: general biochemistry. 2 credits. (Alternate years; offered in 1968-69.)

#### **842. Biochemistry of Nucleic Acids**

The chemistry and metabolism of nucleic acids and their role in protein biosynthesis. Mr. Herbst. Prerequisite: general biochemistry. 2 credits. (Alternate years; not offered in 1968-1969.)

#### **850. Physical Biochemistry**

The physical chemistry of biological molecules with emphasis on the structure and properties of proteins. Beginning with the physico-chemical properties of water and the amino acids, discussion will proceed to the primary structure, conformation, and interactions of proteins. Included will be a consideration of the theory and applications of physical methods such as X-ray diffraction, optical rotation, spectra, sedimentation, and light scattering. Mr. Klippenstein. Prerequisite: physical chemistry and general biochemistry. 2 credits.

#### **852. Advanced Biochemistry Laboratory**

Application of chemical and physical techniques to the purification and characterization of proteins and nucleic acids. Separation methods including various types of chromatography and

electrophoresis will be used. Ultra-centrifugation, spectroscopy, osmometry, and viscometry will be among the techniques employed to study macromolecular structure. To be taken in conjunction with Biochemistry 850. Mr. Klippenstein. 2 laboratories; 2 credits.

**895, 896. Graduate Projects**  
Staff. Prerequisite: satisfactory preparation in analytical, organic, and biological chemistry. Subject matter and hours to be arranged. 1-3 credits.

**897, 898. Biochemistry Seminar**  
Presentation and discussion of recent investigations. Mr. Herbst and staff. Prerequisite: permission of the Department Chairman. 1 credit.

**899. Master of Science Thesis**  
To be arranged. 6-10 credits.

**999. Doctoral Research**

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## Biology (41)

Paul A. Wright, *Chairman of Committee*

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Students admitted to graduate study in Biology must have completed an undergraduate major in Biology or in some field of the biological sciences. Suitable training in the physical sciences is also necessary. Students who lack undergraduate training in any of the fields of the biological sciences may be required to complete certain courses in these fields which do not carry graduate credit before they are admitted to candidacy for a degree.

Graduate work in Biology is under the direction of a committee consisting of the chairmen of the departments of Botany, Entomology, Microbiology, and Zoology. This committee shall determine, in light of the student's objectives, courses and requirements to be met by the candidate. Candidates for the Master's degree in Biology shall pass a written examination covering their

general preparation in the field. A student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree.

## 612. Invertebrate Biology for Science Teachers

A study of readily available forms, principally insects, which have particular application for use in school science courses, concentrating upon living organisms in both field and laboratory. Mr. Schaefer. Prerequisite: two biology courses or permission of instructor. 2 lectures; 2 laboratories; 4 credits.

**791. Biology-Education. Problems in the Teaching of High-School Biology**  
Objectives and methods of teaching, selection and organization of materials, preparation of visual aids, setting up of aquaria and other projects. The use of the field trip as a tool in teaching high school biology. Mr. Schaefer. Prerequisite: two years of biological sciences and Principles of Teaching. 2 lectures; 1 laboratory or field trip; 3 credits. For listings of other courses see: Botany, Entomology, Microbiology, and Zoology.

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## Botany (27)

Thomas E. Furman, *Chairman*

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Students admitted to graduate study in Botany are expected to have had adequate preparation in basic Botany courses and in the physical sciences. The candidate for the Master of Science degree will be required to pass an oral examination and to prepare a thesis. Thesis credits may be from 6 to 10 depending on the research problem involved. Students who are working toward the Doctor of Philosophy degree may be asked to demonstrate knowledge of one or two foreign languages or a cognate field, such as statistics. The doctoral candidacy follows a comprehensive examination, and includes the defense of a thesis which is a substantial

contribution to knowledge.

There is a departmental seminar during the fall semester of each year in which all resident Botany major students are required to participate. The Department's areas for graduate study include:

Systematic Botany, Mr. Hodgdon; Plant Ecology, Mr. Furman; Plant Physiology, Mr. Dunn; Plant Morphology and Anatomy, Miss Nast; Plant Pathology, Mr. Rich and Mr. Shigo; Mycology, Mr. Richards; Cytology, Mr. Schreiber; Phycology, Mr. Mathieson.

#### **742. Plant Ecology**

The structure, development, and causes of distribution of plant communities.

Methods of analysis and interpretation of vegetation are used to present the concepts of ecologic theory. Field exercises will be scheduled for weekends during the latter portion of the course. The student will be expected to defray the cost. Mr. Furman. Prerequisite: Botany 506 (or to be taken concurrently). 3 credits.

#### **751. Plant Pathology**

The nature of disease in plants, the etiology, symptomatology, and classification of plant diseases. Mr. Rich and Mr. Pawuk. Prerequisite: Botany 411 or Biology 401. 1 lecture; 2 laboratories; 3 credits.

#### **752. Principles of Plant-Disease Control**

Exclusion, eradication, protection, and immunization, and the specific, practical methods used to control plant diseases. Mr. Rich. Prerequisite: Botany 751. 1 lecture; 2 laboratories; 3 credits. (Alternate years; not offered in 1968-1969.)

#### **754. Cytology**

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

#### **755. Advanced Systematic Botany**

The principles and laws of plant classification and nomenclature; plant families, field, and herbarium work. Mr. Hodgdon. Prerequisite: Botany 506. Hours to be arranged. (Not offered in 1968-1969.)

#### **756. Plant Physiology**

Structure and properties of cells, tissues, and organs; absorption and movement of water; metabolism; growth and irritability. Mr. Dunn. Prerequisite: Botany 411 or Botany 503 and one year of chemistry. 2 lectures; 2 laboratories; 4 credits.

#### **758. Plant Anatomy**

The anatomy of vascular plants with emphasis on tissue development and structure. Miss Nast. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits.

#### **759. Introduction to Biological Oceanography and Marine Ecology**

The distribution, abundance, and growth of marine plants in relation to their environment (chemical, physical, and biological). Mr. Mathieson. Prerequisite: Botany 780, Zoology 715, or permission of instructor. 2 lectures; 1 laboratory; 3 credits. (Alternate years; not offered in 1968-1969.)

#### **762. Morphology of the Vascular Plants**

Life histories and evolution of both extinct and living pteridophytes, gymnosperms, and angiosperms, including comparisons of the general structure and sexual organs. Miss Nast. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. (Alternate years; offered in 1968-1969.)

#### **765. Microtechnique**

Methods of embedding, sectioning, and staining plant tissues. Introduction to microscopy. Miss Nast. Prerequisite: Botany 411 or Botany 503. 3 credits. (Alternate years; offered in 1968-1969.)

### **766. Freshwater Phycology**

Identification, classification, ecology and life histories of the major groups of freshwater algae. Mr. Mathieson. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. (Alternate years; offered in 1968-1969.)

### **768. Mycology**

The parasitic and saprophytic fungi, their growth, reproduction, and identification. Mr. Richards. Laboratory and assigned reading. 1 lecture; 2 laboratories; 3 credits.

### **780. Marine Phycology**

Identification, classification, ecology, and life histories of the major groups of marine algae. Particular emphasis will be placed upon the New England marine algal flora. Mr. Mathieson. Prerequisite: Botany 411 or Botany 503. 2 lectures; 2 laboratories; 4 credits. (Alternate years; offered in 1968-1969.)

### **795-796. Investigations in (1) Systematic Botany, (2) Plant Physiology, (3) Plant Pathology, (4) Plant Anatomy and Morphology, (5) Plant Ecology, (6) Aquatic Plants, (7) Cytology, (8) Phycology**

Elective only upon consultation with the Department Chairman. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr. Schreiber, and Mr. Mathieson. Hours to be arranged. 2 to 6 credits.

### **797-798. Botany Seminar**

Library reference work and the preparation of papers and abstracts. Practice in the preparation of oral and written reports. Botany Staff. Prerequisite: 6 hours of botany or permission of the Department Chairman. 0 credit.

### **801. 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 ac-

tivities. The major contributions from Humboldt to the present time. Mr. Hodgdon. 3 credits. (Alternate years; not offered in 1968-1969.)

### **805. Advanced Plant Physiology**

Plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, growth regulator effects. Mr. Dunn. Prerequisite: Botany 56 or equivalent, or adequate preparation in the physical sciences. Conferences, laboratory, and assigned reading. 3 or 4 credits. (Alternate years; not offered in 1968-1969.)

### **830. Morphogenesis**

The study of form and development as affected by internal and external factors. Miss Nast. Prerequisite: Botany 758 and 762. 3 credits. (Alternate years; not offered in 1968-1969.)

### **851. Advanced Plant Pathology**

Advanced theories and methods in plant pathology. Mr. Rich and Staff. Prerequisite: Botany 751 and permission of instructor. Assigned reading, conferences, and laboratory. 3 credits. (Alternate years; not offered in 1968-1969.)

### **880. 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 780 or its equivalent. 3 or 4 credits. (Alternate years; not offered in 1967-1968.)

### **895-896. Investigations in (1) Systematic Botany, (2) Plant Physiology, (3) Plant Pathology, (4) Plant Anatomy, (5) Plant Ecology, (6) Mycology, (7) Cytology, (8) Phycology, (9) Botanical Teaching, (10) Morphology**

Elective only upon consultation with the Department Chairman. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr.

Richards, Mr. Schreiber and Mr. Mathieson. Hours to be arranged. 2 to 6 credits.

899 (899). Master of Science Thesis  
6-10 credits.

999 (999). Doctoral Dissertation

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## **Business Administration (71)**

Jan Cleo, *Dean*

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### **Whittemore School of Business and Economics**

The Whittemore School program leading to the degree of Master of Business Administration is designed to prepare its graduates for professional careers in administration in industrial and other organizations in a rapidly changing world. It provides for knowledge and understanding of management principles and practices 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 business, and (3) the role of business and other organizations in an increasingly complex and ever-changing society. Candidates for admission must normally possess a Bachelor's degree from an accredited college or university. Applicants will generally be expected to have completed their undergraduate programs of study with a cumulative academic average of at least 2.5 or the equivalent. In addition, all candidates are expected to take the Admissions Test for Graduate Study in Business (ATGSB) given by the Educational Testing Service.\* The Whittemore School welcomes applicants with any academic background, but previous work in mathematics,

economics, the behavioral sciences, and the various branches of engineering are of particular relevance to graduate study in Business Administration. Because of the increasing use of mathematical concepts, models and notation in the practice and study of business administration, applicants should normally have successfully completed one year of college mathematics through an introduction to the calculus.

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

The program leading to the Master of Business Administration degree requires two years of full-time study. The first year of the program consists of separate courses integrated into an overall study of the nature of business administration in a rapidly changing environment. In the first semester, the student will be largely concerned with study of concepts and analytical techniques drawn from the basic disciplines, such as economics, mathematics, psychology, and sociology, which underlie business administration. In the second semester, some work in the behavioral and quantitative areas is continued and courses dealing with the functional areas of business are introduced. In these courses the concepts and techniques developed in the early part of the year are utilized in dealing with specific business problems.

The second year continues the emphasis of the first year on overall management by requiring all students to complete the integrating course entitled Policy Formulation and Administration. Special attention is also given in the second year to the changing and increasingly complex external environment in which management functions by requiring all students to complete the course entitled Conceptual Foundations of Business. In addition, the student will select the

\*Details concerning times, places, etc., for these examinations may be obtained from Education Testing Service, Box 966, Princeton, N. J. 08540.

equivalent of eight semester courses from among those offered in Business Administration and Economics by the Whittemore School and by other colleges and departments of the University. In selecting these courses the student will normally be expected to develop some concentration by taking at least two semester courses but not more than three semester courses in one of the several designated areas. Where the student elects courses offered by other colleges of the University such selection requires approval of the Dean of the Whittemore School.

### **725. Business History**

A survey of the development of business enterprise and its institutions in Western Europe and the United States from the late Middle Ages to the era of the giant diversified corporation. Emphasis is placed on the role of the entrepreneur, the impact of public policy on business, and the case study of individual firms. 3 credits. (This course is the same Economics 725.)

### **727. 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, is 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. Mr. Ladd. 3 credits.

### **730. Organization Theory**

Examination of major theories and conceptual ideas pertinent to describing, analyzing, and predicting the nature

and behavior of formal organizations. Emphasis is on class discussion and individual written analysis of selected theoretical reading. Mr. Jenks. Prerequisite: permission of instructor. 3 credits.

### **731. Group Dynamics**

Intensive experimental study of the dynamics of small groups through the laboratory method. Course combines the use of the classroom itself as a laboratory with readings to explore the impact of such variables as norms, power, imbalances, social roles, and interpersonal relations on small group functioning and on personal behavior in group settings. Prerequisite: permission of the instructor. Mr. Jenks. 3 credits.

### **747. 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 problems. The course is built upon lectures, classroom discussions, some creative research, and weekly case analyses. Mr. Marschner. 3 credits.

### **750. Advanced Marketing Management**

The interrelation of marketing with production and finance. Topics include planning and developing the product, testing, brand management, packaging, sales organization, forecasting, and control. Policy formulation and decision making are emphasized. Mr. Marschner. 3 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. 3 credits.

### **753. Comparative Marketing**

The identification and analysis of common factors and differences in marketing concepts, systems, techniques, and institutions among various societies and nations in the world today. Conducted by a visiting professor from a Western European university, the course will be comprised largely of lectures and classroom discussions, based upon extensive outside readings from modern marketing literature. Mr. Hansen. 3 credits.

### **756. Federal Taxation**

Current federal income, estate, and gift taxes and their impact on corporations, partnerships, and individuals. 3 credits.

### **758. 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 structures, 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. Mr. Horrigan. Prerequisite: Some previous work in financial accounting would be extremely helpful. 3 credits.

### **762. 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. 3 credits.

### **763-764. Advanced Financial Accounting I and II**

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. Mr. Horrigan. Prerequisite: permission of instructor. 3 credits.

### **765. Advanced Financial Management**

Financial policy of the firm with emphasis on solutions to complex problems of cost of capital, leverage, optimal capital structure, capital budgeting, and working capital management. Discussion of abstract models and how they can be modified and applied to concrete situations. Cases may be used. Mr. Wetzel. Prerequisite: permission of instructor. 3 credits.

### **771. Corporations**

The role of the modern corporation in the economy. Emphasis upon structure of the corporation, the corporate system, combinations, and concentration. Mr. Degler. Prerequisite: Economics 402. 3 credits.

### **775. Operations Research**

Mathematical programming, game theory, inventory, queuing, and scheduling problems, dynamic programming. Mr. Korbel. 3 credits.

### **776. 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. 3 credits.

### **790. Seminar in Business Problems**

Special topics in business administration. This course may be repeated. Prerequisite: consent of the adviser and the instructor. Credits to be arranged.

### **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. Mr. Clee. Prerequisite: permission of instructor. 3 credits.

**801. Quantitative Analysis**

Calculus, difference equations, and matrix algebra with business applications. 3 credits. (Open to full-time Master of Business Administration students only.)

**802. Quantitative Analysis**

Probability, sampling, inference, regression, econometric models. 3 credits. (Open to full-time Master of Business Administration students only.)

**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. 3 credits. (Open to full-time Master of Business Administration students only.)

**804. Management Organization**

The historical development of theories and structures of organization and analysis of contemporary organization theory and structure. Concern is with development of rational management processes in a dynamic society. 3 credits. (Open to full-time Master of Business Administration students only.)

**806. Financial Management**

Concepts and techniques for determining the need for, the acquisition of, and the management of financial resources of the business. 3 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 familiarity with present knowledge

of the determinants of economic growth and fluctuations. 3 credits. (Open to full-time Master of Business Administration students only.)

**808. Marketing Management**

Identification, development, and retention of markets for the goods and services offered by the firm. Attention is given to the dynamics of demand and to the blending of the marketing mix. 3 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. 3 credits. (Open to full-time 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 about business and views of businessmen about themselves. 3 credits. (Open to full-time Master of Business Administration students only.)

**812. Policy Formulation and Administration**

Top management functions of planning, organizing, and evaluating the results of actions taken. The general management point of view rather than that of functional departments is stressed and as such continues the integrating approach of the first year. 3 credits. (Open to full-time Master of Business Administration students only.)

**815-816. Financial Reporting and Economic Analysis for Management**

An integrated view of accounting and economic analysis. Its 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. Mr. Ladd. 3 credits.

### 861. Control and Information Systems

The concepts of systems, their use in enterprise management, and the role and influence of on-line control systems; the nature and uses of information in management. The course includes materials intended to familiarize the student with software techniques and hardware characteristics related to "information technology". Mr. Beckett. 3 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. 3 credits.

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## Chemical Engineering (80)

Oswald T. Zimmerman, *Chairman*

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To be admitted to graduate study in Chemical Engineering an applicant shall be 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. An entrance examination covering basic subjects in chemical engineering will be given to all entering graduate students before registration. No one will be admitted as a candidate for a degree until he has passed all portions of the entrance examination.

A candidate for the Master's degree in Chemical Engineering may choose either to prepare a thesis, for which up to

six credits will be allowed, or to take an equivalent amount of course work.

Students who do not prepare a thesis will be required to enroll in Chemical Engineering 890 at their earliest opportunity. These candidates will be required to take a comprehensive oral examination prior to completion of the Master of Science program in place of the customary defense-of-thesis examination.

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.

### 641. Physical Metallurgy

The nature of metals, emphasizing the quantum mechanical description of the solidstate and including atomic structure, bonding, historical development of metal theories, elementary zone or band theory, and X-ray diffraction. The microscopic metal system, thermodynamics of metallurgical processes, defects and dislocations, phase relations of pure metals and alloys, microstructure, and physical and thermal treatment of metals. Study of some non-metals. 3 lectures; 1 laboratory; 4 credits.

### 662. Chemical Engineering Economics and Plant Design

The principles of cost engineering, including estimation of plant investment, working capital, operating costs, labor requirements, payout time, and profitability. Value of money, capitalized costs, simple and compound interest, depreciation, taxes and insurance, labor requirements, overhead, financing of chemical enterprises, design of equipment and plants for minimum cost, plant location, transportation, sales cost, equipment cost, and cost indexes. Each class selects one or more problems involving the complete design of a chemical plant. For each problem, the most desirable process must be determined, the site selected,

the equipment and plant designed, calculations made for all costs, profitability and payout time, and a complete report prepared, including the drawings of equipment and plant layout. 1 lecture; 3 laboratories; 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. 3 credits.

#### **762. Introduction to Optimization**

Optimization techniques applied to functions not described analytically. Search techniques include Fibonacci search, golden section search, method of steepest ascent, method of contour tangents, and the method of parallel tangents. Stochastic schemes are considered. Advanced techniques for the optimization of objective functions are considered from a qualitative viewpoint. 3 credits.

#### **781. 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. 2 lectures; 1 laboratory, 3 credits.

#### **813. Introduction to Fluid Dynamics**

Equations of change for continuous fluids, laminar Newtonian and non-Newtonian flow; ideal fluid flow; boundary layers methods; turbulence. 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 multicomponent 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 nonlinear processes. Special attention is given to representing a complex process by differential equations, linearizing nonlinear elements, and adequately controlling the entire system. 3 credits.

#### **871. 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 graduate students. 3 credits.

### **872. 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 graduate students in chemical engineering. 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.

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## **Chemistry (81)**

Alexander R. Amell, *Chairman*

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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 Depart-

ment feels that the experience of teaching is a valuable part of the training of the graduate student. Therefore, all graduate students who are Doctors of Philosophy or Masters 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 general 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.

### **Chemical Physics and Soil and Water Chemistry Options**

Doctor of Philosophy candidates in Chemistry may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Physics, or the Soil and Water Chemistry program, an interdisciplinary program offered jointly with the Department of Soil and Water Science. In these options, the doctoral 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.

## Master of Science Degree

Admission to this program is based upon a cumulative undergraduate average of 2.5 and requires satisfactory work in the usual undergraduate courses in general 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.

## Inorganic Chemistry

### 775. Inorganic Chemistry

The relationship between chemical reactions and modern concepts of inorganic chemistry on a moderate level. The applicability and limitations of the newer ideas. Mr. Haendler, Mr. Weber. Prerequisite: Chemistry 683-684 or permission of instructor. 3 credits.

### 804. Advanced Inorganic Chemistry

A survey from the modern point of view, with emphasis on theoretical and structural concepts. Mr. Haendler, Mr. Weber. Prerequisite: Chemistry 775 or its equivalent. 3 credits.

### 847. Advanced Inorganic Chemistry

The chemistry of coordination compounds, their ligand field spectra, magnetic-properties, and reaction mechanisms. The metal-ligand bond in crystal field and molecular orbital theories. Prerequisite: Chemistry 804 or permission of instructor. Mr. Weber. 3 credits.

### 848. Advanced Inorganic Chemistry

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

## Analytical Chemistry

### 661. Analytical Chemistry

A thorough treatment of the theory and techniques of gravimetric and volumetric analysis followed by special methods of analysis, such as ion exchange and EDTA titrations. Mr. Daggett. Prerequisite: Chemistry 405-406 or equivalent. 3 lectures; 2 laboratories; 5 credits.

### 762. Instrumental Analysis

A treatment of the theory, instrumentation and application of methods such as emission spectrography, flame spectrometry, spectrophotometry, gas chromatography, coulometry, potentiometry, conductimetry and polarography to chemical analysis. Mr. Daggett. Prerequisite: Chemistry 661; Chemistry 684 as a prerequisite or concurrently or permission of instructor. 3 lectures; 2 laboratories; 5 credits. Cannot be used for graduate credit by chemistry students.

### 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. Mr. Ellis. 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. Mr. Daggett. 3 credits.

**832. Chemical Instrumentation**

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

**Organic Chemistry****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. Staff. 1-3 credits.

**755. Advanced Organic Chemistry**

The preparation of organic compounds is studied with consideration being given to structural and stereochemical control of the reactions from a knowledge of the mechanism of the reaction. Emphasis is on the solution of assigned problems. Prerequisite: one year of organic chemistry and physical chemistry or permission of instructor. 3 credits.

**756. Characterization of Organic Compounds**

The spectroscopic and chemical properties of organic compounds provide a basis of the systematic characterization of organic structures. Methods for the separation of mixtures of organic compounds are considered. Mr. Lyle. Prerequisite: one year of organic chemistry. 1 lecture; 2 laboratories; 3 credits.

**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 discussions of theoretical and experimental methods used in the study of reaction mechanisms. 3 credits.

**807. Introduction to Research Techniques**

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. Staff. 2 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. Mr. Lyle, Mr. Jones, Mrs. Lyle, Mr. Andersen, Mr. Uebel, and Mr. Morrison. 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 utilizes radiochemical operations. Prerequisite: general inorganic chemistry and general physics. Mr. Amell or Mr. Owens. 2 lectures; 2 laboratories; 5 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 523 or 426 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 523 or 426 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. 3 credits.

### 805, 806. Advanced Physical Chemistry

Wave mechanics and quantum chemistry, spectroscopy, molecular 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 photochemistry. Mr. Amell or Mr. Owens. Prerequisite: one year of physical chemistry. 3 credits.

### 822. Physical Chemistry — Chemical Thermodynamics

The foundations and inter-relationships of the theory of thermodynamics. The methods by which the theoretical principles may be applied to practical problems. Mr. Wheeler. 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. Mr. Amell or Mr. Owens. 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. Mr. Pilar. 3 credits.

### 829. Theoretical Chemistry III

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

**895, 896. Colloquium in Chemistry**  
a. INORGANIC CHEMISTRY, b. ORGANIC CHEMISTRY, c. THEORETICAL ORGANIC CHEMISTRY, d. PHYSICAL CHEMISTRY, e. 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**

Present-day 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. Prerequisite: freshman chemistry. 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 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 current theories of reactions. Prerequisite: general chemistry. 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 794 or its equivalent. 4 credits.

**789. Atomic and Molecular Structure**  
The methods of determining atomic and molecular structure, including ultra-

violet and infrared spectroscopy and radiochemistry. 4 credits.

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## Civil Engineering (82)

J. Harold Zoller, *Chairman*

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A candidate for the degree of Master of Science in Civil Engineering must have completed a course of study equivalent to that required by this department for the baccalaureate degree or he must take specified courses in the areas of deficiency without credit. An oral final examination is required of all candidates.

A candidate for the Master's degree will normally complete a thesis for not less than 6 nor more than 9 hours of credit. With the permission of the department, a student may be permitted to substitute approved course work for the thesis requirement. In this event he must also submit to his examining committee a paper written in one of his courses, which shall be the equivalent of a thesis in style and quality, but not in scope. One copy of the thesis or paper is required by the department.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

Courses numbered above 700 may be offered biennially or upon demand. Permission of the instructor and consent of the student's adviser are required for enrollment in all Civil Engineering courses.

### 620. Transportation Engineering

The development, organization, administration, and inter-relation of transportation systems and facilities, including railroads, highways, airports, waterways, and pipe lines. Major emphasis will be given to the economics of location, geometric and structural design, construction materials, methods, and costs, as applied to modern transportation engineering. Prerequisite: Civil Engineering 506. 3 credits.

**643. Water Supply and Treatment**  
The sources, quantity, quality, and sanitary aspects of public water supplies. Methods of purification and distribution systems. 3 lectures; 1 laboratory; 4 credits.

**644. Sewerage and sewage treatment**  
The theory and problems of sewerage, the principles governing the disposal of sewage, and the various methods of sewage treatment. Prerequisite: Civil Engineering 643. 3 lectures; 1 laboratory; 4 credits.

### 665. Soil Mechanics

Soil classification, physical properties including permeability, compressibility, bearing capacity, settlement, and shear resistance are related to the principles underlying the behavior of soils subjected to various loading conditions. Underground exploration and typical foundation problems are included. 3 lectures; 1 laboratory; 4 credits.

### 711. Community Planning

Social, economic, and physical factors; content and extent of desirable programs, including purpose and scope, the preliminary survey, elements of community land planning, the master plan, transportation systems, street patterns and traffic, motor vehicle parking, airport sites, public building sites, parks and recreational facilities, zoning, control of land sub-division, neighborhood centers, housing, legal, financial and economic problems, and redevelopment of blighted areas. Mr. Dawson. 3 credits.

### 714. Contracts, Specifications, and Professional Relations

The essential elements required in engineering contracts; the purposes and content of specifications; professional conduct, relations, and ethics; and estimating by means of quantity surveys and unit cost methods. Mr. Dawson. 3 credits.



**721. Highway Engineering I**

Highway organization, administration, finance, economics, planning, traffic surveys, operations; highway laws, contracts, specifications; highway capacity, geometric design, access control, safety, accident studies; pavement performance and evaluation. Prerequisite: Civil Engineering 620. 3 credits.

**722. Highway Engineering II**

Design of flexible and rigid pavements and bases for highways, airports, and city streets; soil exploration, pavement selection, construction methods, materials, specifications, and engineering cost estimates. Prerequisite: Civil Engineering 620 and 665. 3 credits.

**741. Hydraulic Engineering**

Application of fluid mechanics to hydraulics problems, such as reservoirs, dams, control works, open-channel flow, hydro-electric power, irrigation, drainage, and multi-purpose projects. Prerequisite: Civil Engineering 642. 2 lectures; 1 laboratory, 3 credits.

**742. Hydrology**

The occurrence and physical effects of water on the earth, including meteorology, groundwater runoff, and streamflow routing. Prerequisite: Civil Engineering 642 or as a prerequisite concurrently. 2 lectures, 1 laboratory, 3 credits.

**782. Wood Structures**

Properties and characteristics of structural woods, connection methods, design of timber members and connections in beams, columns, and trusses, and glued laminates of wood. Prerequisite: Civil Engineering 692. 1 lecture; 1 design period; 2 credits.

**784. Topics in Structural Engineering**

Presentation of a unifying concept of basic structural theories; introduction to matrix and numerical methods of analysis; introduction to beams on elastic

foundations. Prerequisite: Civil Engineering 685. 3 credits.

**790. Limit Design**

Introduction to modern design theories; ultimate design of reinforced concrete and plastic analysis of steel structures. Prerequisite: Civil Engineering 685 and 693. 2 lectures; 1 design period; 3 credits.

**841-842. Advanced Hydraulics**

Sediment transportation, secondary flows, design of hydraulic structures, reservoir and channel routing techniques, basic hydrodynamics and independent study. 3 credits.

**843-844. Experimental Hydraulics**

Experimental techniques and laboratory practice. Experimental studies of the fundamental phenomena of liquid flow. Mr. Dawson. Prerequisite: Civil Engineering 642. 3 credits.

**855-856. Advanced Hydraulic and Sanitary Engineering**

Hydrology, hydraulics of river flow, flood flows, design of reservoirs, flood control, river control, and hydraulic and sanitary structures. Water treatment and sewage treatment practices. Prerequisite: Civil Engineering 643 and 644. 3 credits.

**863-864. Soil Mechanics**

The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, earth pressure, and seepage studies. Prerequisite: Civil Engineering 665. 3 credits.

**865. Soil Testing for Engineering Purposes**

The essential tests for the physical properties: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. 2 to 4 credits.

### **866. Foundation Engineering**

Application of the principles of soil mechanics to selection of type of sub-structure, foundation construction methods, exploratory soil studies, stability analysis, earth dam and tunnel construction, and underpinning operations.

Prerequisite: Civil Engineering 665.  
3 credits.

### **881. Advanced Structural Analysis I**

Unifying network concepts of structural analysis. Advanced structural theory and analysis including multi-story structures, beam-columns, frames with variable moment of inertia, continuous trusses and bents, and influence lines.

Prerequisite: Civil Engineering 685.  
3 credits.

### **882. Advanced Structural Analysis II**

Advanced analysis including arches and curved frames, space frames, rings and closed frames, shear flow and flexural stresses in thin walled sections, suspension bridges, folded plates, and introduction to structural dynamics.

Prerequisite: Civil Engineering 881.  
3 credits.

### **883. Advanced Structural Design**

Ultimate strength design in reinforced concrete. Prestressed concrete design. Plastic design of steel structures. Prerequisite: Civil Engineering 685. 3 credits.

### **895, 896. Civil Engineering Problems**

The study and investigations of problems selected to meet the needs of the student. 2 or 3 credits.

### **899. Master's Thesis**

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

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## **Economics (72)**

Jan Clee, *Dean*

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### **Whittemore School of Business and Economics**

Admission to graduate study in Economics 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. Thirty semester hours of graduate study or 24 semester hours and a thesis: (a) a minimum of 21 semester hours in courses numbered 700 and above, of which 6 hours may be satisfied by an acceptable thesis; at least 9 of these hours, exclusive of the thesis, must be in courses numbered 800 and above; (If a thesis is to be submitted, it must be in form for presentation to the Reading Committee by May 1 of the year in which the degree is to be granted.) (b) a maximum of 9 semester hours in approved courses numbered 600 and above 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) 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 and the History of Economic Thought

**704, 705. Economic History I and II**  
An analysis of the growth of the American and European economies. 3 credits.

**725. Business History**  
Development of business enterprise and its institutions in Western Europe and the United States from the late Middle Ages to the era of the giant diversified corporation. The role of the entrepreneur, the impact of public policy on business, and the case study of individual firms. 3 credits. (This course is the same as Business Administration 725.)

**727. Public Policy in Social and Labor Legislation**  
American social and labor legislation of the recent decades and the way in which American economic and human values have been implemented and modified by law. Legislation and private industry programs in social security, reemployment, unemployment insurance, health services, training and retraining, and fair employment practice. Lectures, discussion, assigned reading, and individual student projects. Mr. McConnell. 3 credits. (This course is the same as Sociology 727.)

**754. Advanced Money and Banking**  
Emphasis on central banking, monetary policy and monetary theory. Study of current problems and developments in banking. Mr. Degler. 3 credits.

**774. Mathematical Economics**  
The principal mathematical techniques and their application in economics. Mr. Braff. Prerequisite: permission of instructor. 3 credits.

**776. Economic Fluctuations**  
Recurrent movements of prosperity and depression, with emphasis upon causes and public policy implications. Mr. Rosen. Prerequisite: Economics 675 or permission of instructor. 3 credits.

**781. Advanced Statistics**  
The theoretical basis of statistical methods, probability, probability distributions, statistical inference, and decisions. Mr. Cole. Prerequisite: permission of instructor. 3 credits.

**782. Econometrics**  
The application of statistics and mathematics to economic problems. The formulation of economic models, their measurement and verification. Mr. Cole. Prerequisite: permission of instructor. 3 credits.

**784. Statistical Decision Making**  
The application of probability and statistics to decision problems. Special emphasis on the Bayesian approach to decisions under uncertainty. Mr. Braff. Prerequisite: permission of instructor. 3 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. Mr. Hogan. 3 credits.

**852. Economics of Collective Bargaining**  
Tools of economic analysis applied to collective bargaining — wages, productivity, seniority rules, job security, package bargaining. Application to cases. Mr. Hogan. 3 credits.

**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, particularly with reference to the applicability of their theories to current economic problems. Mr. Bowring. 3 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. Mr. Irwin. 3 credits.

**861. Economic Systems**

Analysis of the functioning of various types of national economic systems. Emphasis on economic planning and development. Mr. Donovan. 3 credits.

**863. International Economics**

Contemporary issues in international economic theory and policy. Analysis of trade theory, balance of payments problems, international liquidity, and the adjustment processes. Mr. Rothwell. 3 credits.

**873. Macro-economic Theory**

Advanced analysis of such aggregates as national income, total output, employment and the general price level. Examination of the major aggregate models. Mr. Rosen. 3 credits.

**878. Micro-economic Theory**

Topics in micro-economics with emphasis on recent developments in such areas as general equilibrium analysis, welfare economics, demand theory, and capital theory. Mr. Braff. 3 credits.

**891. Seminar in Monetary Theory and Policy**

Contemporary developments in monetary theory and the evaluation of policy measures. Mr. Wrightsman. 3 credits.

**892. Seminar in Public Finance — Theory and Policy**

Selected topics in contemporary theoretical and policy problems of public finance. Mr. Schulz. 3 credits.

**894. Seminar in Economic Development**

A survey of theories and detailed case studies in problems of economic development. 3 credits.

**895-896. Independent Study**

Selected projects. Staff. 6 credits.

**899. Thesis**

Staff. 6 credits.

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## Education (48)

Roland B. Kimball, *Chairman*

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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.

The Department offers courses leading to the Master of Education degree and to the Master of Arts in Teaching degree.

### Master of Education

Master of Education programs are offered in the following areas of specialization:

Elementary Education

Secondary Education

Counseling and Personnel Services

Reading

Administration and Supervision

School Library Science

Specific requirements for completion of the programs vary with the area of specialization. For further information, write to the Chairman, Department of Education.

### **Thesis or Comprehensive Examination**

Candidates in the Master of Education program ordinarily will be expected to complete a research thesis, or a comprehensive examination, which may be written or oral. Each candidate will plan this portion of his program in terms of his own professional situation and in consultation with his graduate adviser. There is no thesis or examination requirement for the Master of Arts in Teaching.

### **Master of Arts in Teaching**

The Master of Arts in Teaching program is designed for candidates who have completed an undergraduate degree with a strong academic major but have not followed a program of professional preparation for teaching. The Master of Arts in Teaching program will provide a balanced curriculum in teacher preparation with heavy emphasis on a supervised internship in teaching and an opportunity to complete further graduate work in the academic subjects most closely related to the candidate's teaching field.

Candidates will spend two summers and the intervening academic year in graduate study. The first summer will provide an opportunity to study and practice educational methods under the supervision of master teachers in the University's summer high school. During the academic year the student will be placed in a local school system as a teaching intern with a half-time load. Interns will be paid by the local school system, according to the policy of the local school board. Concurrently the intern will attend seminars on campus which will extend his grasp of educational theory and method and will relate these

studies to the experiences the intern encounters as a teacher in a school system. The final summer will complete the courses included in the program.

In 1968-69 the Master of Arts in Teaching programs will be open to prospective secondary and elementary school teachers of English, mathematics, sciences, social studies, and foreign languages. For further information, write to the Director, Master of Arts in Teaching, Department of Education.

### **Certificate of Advanced Graduate Study**

There is a post-master's degree program in counselor education leading to a Certificate of Advanced Graduate Study. Applicants for admission to this program must meet the entrance requirements described on page 17. For further information, write to Professor Angelo V. Boy, Department of Education.

#### **733. Teaching the Language Arts**

Comparison of current schools of thought with regard to language arts instruction. Discussion of procedures, materials and diagnostic and evaluative techniques. Emphasis on improving oral expression, functional and creative writing, literature and spelling. Correlation of language arts with other areas of the curriculum. 3 credits.

#### **734. Children's Literature**

The consideration of children's books and methods of using them. Lectures and the opportunity to examine and evaluate a wide variety of books for children of all ages, with emphasis on the intermediate grades. Practical demonstrations of how to correlate children's books with various special subjects. 3 credits.

#### **735. The Teaching of Elementary School Foreign Languages**

Methods and materials for the audio-lingual teaching of foreign languages in the elementary school. 3 credits.

**736. The Teaching of Elementary School Social Studies**

Designed to help elementary teachers develop a social-studies program. It includes a study of the methods and materials which seem to be most effective in this field. The psychological development of children of different ages. 3 credits.

**737. The Teaching of Elementary School Mathematics**

Formation of number concepts and the development of arithmetic skills. Modern methods of teaching arithmetic are demonstrated. Prerequisite: teaching experience. 3 credits.

**739. The Teaching of Elementary School Science**

Emphasis is placed on the learning process and the instructional techniques necessary for teaching the major concepts from science. 3 credits.

**745. Elementary School Curriculum Reorganization**

The theories and procedures of curriculum development in the elementary school. Prerequisite: teaching experience. 3 credits.

**753. Teaching Exceptional Children**

The organization, materials, and methods suitable for the instruction of atypical children. Emphasis will be given to the teaching of creative children. Use of prose, poetry, creative dramatics, and similar teaching techniques. 3 credits.

**757. Psychology of Human Learning**

Psychology of learning as it operates within the classroom. Prerequisite: Education 481 and permission of department. 3 credits.

**758. Principles of Teaching**

Application of the theories of learning studied in Education 757, with emphasis upon the following: organization of content, specific planning, and a study of procedures essential to the evaluation

of the learning processes. Prerequisite: Education 757 and permission of department. Two 2-hour recitation-laboratories; 3 credits.

**759. Principles of Education**

American schools have developed, and are still developing, in unique forms quite unlike their European counterparts. Among Americans, however, there are basic disagreements concerning the direction our schools should take. This course deals with these conflicts of philosophy, the problems of American education, and research pertinent to these problems. Prerequisite: Education 757 and permission of department. 3 credits.

**763. Instructional Media**

To help improve ability to communicate ideas through materials and equipment commonly available in a school audio-visual center. Educational films, bulletin board design, the role of language labs, educational television, programmed learning, and media research. A laboratory period of one hour each week is required in addition to the regular class period. Prerequisite: Education 757 or permission of instructor. 3 credits.

**785. Educational Tests and Measurements**

An introduction to the theory and practice of educational evaluation. Emphasis given to use of test results in classroom teaching and student counseling. Analysis of standardized tests in terms of (a) their psychological, or factorial, meanings and (b) their practical, or predictive, uses. Prerequisite: Education 757. 3 credits.

**787. Principles of Elementary Education**

The underlying principles of education as applied to the teaching of children in elementary schools will be coordinated with the fundamentals of educational psychology and translated in terms of methods of teaching. Adaptations of vari-

ous methods and plans as carried on in modern elementary schools. 3 credits.

### **807. Improvement of Reading**

Comparison of current schools of thought with regard to reading instruction. Discussion of procedures, materials, and diagnostic and evaluative techniques. Emphasis on small group and individual activities to assure the mastery of basic reading abilities. The use of reading in school and leisure situations. Prerequisite: teaching experience. 3 credits.

### **808. Diagnostic and Remedial Procedures in Reading**

The techniques of analysis and correction or prevention of problems in reading, spelling, and language. Discussion and demonstration of diagnostic tests and remedial methods. Practice in clinical analysis, techniques of work with individuals, teams, small groups, and classes. Prerequisite: Education 807. 3 credits.

### **809. Reading Clinic**

Practicum in improvement of reading including direct experience with children having reading difficulties. Seminars will consider individual cases and remedial procedures. Prerequisite: Education 808 (may be taken concurrently) and permission of instructor by June 1. 3 credits.

### **830. Psychology and Education of Exceptional Children**

Psychological problems of handicapped children and a consideration of the implications for educational practice. Prerequisite: Education 757. 3 credits.

### **831. Seminar and Practicum for Master of Arts in Teaching (Elementary School)**

Practicum and related seminars as follows: (a) SEMINAR IN EDUCATIONAL PSYCHOLOGY. Developmental psychology covering the period from early childhood through adolescence. Specific attention given to applications of psychological theory to classroom practice. (b) SEMINAR IN EDUCATIONAL METHODOLOGY. The

elementary school curriculum and methods of instruction in reading and elementary mathematics. This seminar will be directly related to experience of candidate in the practicum. (c) PRACTICUM. Observation of master teachers in reading and elementary mathematics assigned to the University Summer Elementary School. Opportunities to teach elementary school children under the supervision of the master teachers. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching program. 9 credits.

### **832. Internship and Seminar for Master of Arts in Teaching (Elementary School)**

Internship and related seminars as follows: (a) SEMINAR IN EDUCATIONAL PSYCHOLOGY. Advanced study in developmental psychology and systematic study of cognitive psychology. Specific attention given to applications of theory in solving problems of classroom instruction encountered in the internship. (b) SEMINAR IN EDUCATIONAL METHODOLOGY. The elementary school curriculum and methods of instruction in elementary school science, social science, music, art, and physical education. This seminar will be directly related to planning instruction offered by the student as an intern teacher. (c) INTERNSHIP. Half-time elementary school teaching under the supervision of the University faculty. (First semester only.) Prerequisite: Education 831. 6 credits.

### **833. Internship and Seminar for Master of Arts in Teaching (Elementary School)**

Internship and related seminars as follows: (a) SEMINAR IN HISTORICAL AND SOCIAL FOUNDATIONS OF EDUCATION. The history of public education in the United States and the contemporary social conditions which influence public education today. (b) SEMINAR IN EDUCATIONAL METHODOLOGY. A continuation of the seminar started in Education 832. (c) INTERNSHIP. Half-time elemen-

tary school teaching under the supervision of the University faculty. (Second semester only.) Prerequisite: Education 832. 6 credits.

**835. Seminar and Practicum for Master of Arts in Teaching (Secondary School)**

Practicum and related seminars as follows: (a) SEMINAR IN EDUCATIONAL PSYCHOLOGY. Developmental psychology covering the period from early childhood through adolescence. Specific attention given to application of psychological theory to classroom practice. (b) SEMINAR IN EDUCATIONAL METHODOLOGY. The secondary school curriculum and general methods of instruction. Candidates will make a detailed study of the secondary school curriculum and special methods of instruction in their own specific teaching field. (c) PRACTICUM. Candidates are assigned to a master teacher in their specific teaching field for observation in the University Summer High School. There will be opportunities for candidates to do supervised teaching in their subject field. (Summer Session only.) Prerequisite: admission to the Master of Arts in Teaching program. 9 credits.

**836. Internship and Seminar for Master of Arts in Teaching (Secondary School)**

Internship and related seminars as follows: (a) SEMINAR IN EDUCATIONAL PSYCHOLOGY. A systematic study of cognitive psychology. Specific attention given to applications of theory in solving problems of classroom instruction encountered in the internship. (b) SEMINAR IN EDUCATIONAL METHODOLOGY. A continuation of the special methods seminar started in Education 835. Candidates elect the seminar which provides a detailed study of the secondary school curriculum and special methods of instruction in their own specific teaching field. This seminar will be directly related to planning instruction offered by the candidate as an intern teacher. (c)

INTERNSHIP. Half-time secondary school teaching in the candidate's major field under the supervision of the University faculty. (First semester only.) Prerequisite: Education 835. 6 credits.

**837. Internship and Seminar for Master of Arts in Teaching (Secondary School)**

Internship and related seminar as follows: (a) SEMINAR IN HISTORICAL AND SOCIAL FOUNDATIONS OF EDUCATION. The history of public education in the United States and the contemporary social conditions which influence public education today. (b) INTERNSHIP. Half-time secondary school teaching in the candidate's major field under the supervision of the University faculty. (Second semester only.) Prerequisite: Education 836. 3 credits.

**842. Library Organization and Service**

Background and development of the school library, including philosophy, functions, objectives and standards. Problems of organization and administration. Relationship to curriculum, teacher, and students, and the public library. 3 credits.

**843. Basic Reference and Informational Services for the School Library**

The selection and evaluation of basic reference materials common to all libraries with special application to the school. Familiarity with informational and research tools and intensive practice in their use. 3 credits.

**844-845. Technical Processes in the School Library**

Organizing materials with special emphasis on classification and cataloguing systems. Practice in the technical arrangement of books, pamphlets, periodicals, recordings, and pictures. Ordering, processing, mending, and binding procedures. 6 credits.



**846. Selection and Acquisition of Books and Other Materials**

Techniques for building the library collection in all subject areas. A wide range of sources, aids, and tools are considered. Intensive reading and analysis of books for children and young people. Practice in the compilation of bibliographies for special levels and interests, and in relating selection to curriculum needs. Prerequisite: Education 842 and 843. 3 credits.

**847. Reading Guidance**

The role of the school librarian in reading growth and development through the promotion of interest and skills in reading. Review of current research and studies on reading and reading habits, the mass media, reading disabilities, and other factors that retard or promote the use of printed materials. Prerequisite: Education 842 and 843. 3 credits.

**848. Directed Research in School Librarianship**

Prerequisite: Education 846 and 847 (may be taken concurrently). 2-4 credits.

**850. Administration of Instructional Materials Programs**

To help public school audio-visual personnel examine the planning, organizing, and communicating activities that provide a foundation for the effective use of newer educational media. Selection, evaluation, in-service training, planning new facilities, a current research and systems design. A previous course in audio-visual education is desirable. Prerequisite: permission of instructor. 3 credits.

**851. Programmed Instruction**

Examination of the advantages and limitations of programmed instruction and its psychological foundation. The various types of teaching machines, the results of experimentation with programmed instruction, and the method of developing programmed instruction material. Prerequisite: Education 757. 3 credits.

**852. Principles and Problems of Secondary-School Curriculum Reorganization**

Significant changes in secondary-school offerings, with emphasis on curriculum revision and techniques of revision. Prerequisite: teaching experience. 3 credits.

**853. Seminar in Curriculum Study**

The techniques and procedures of curriculum development for the purpose of better meeting the educational needs of adolescents. Prerequisite: teaching experience. 3 credits.

**855. Advanced Human Development**

A critical examination of the social psychological, and educational aspects of human development with special emphasis on the role of the school. Prerequisite: Education 481. 3 credits.

**858. Advanced Principles of Teaching**

An opportunity to study problems, principles, and teachings which are involved in planning for pupil learning. Prerequisite: teaching experience. 3 credits.

**861. Public School Administration**

For students who have had teaching or administrative experience, and are looking forward to further work as superintendent, principal, or departmental head. Emphasis on policy-making, management, personnel, public relations, finances, housing, curricula, reporting, and research. Prerequisite: teaching experience. 3 credits.

**862. Educational Finance and Business Management**

Aspects and 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. 3 credits.

**863. Seminar in Educational Administration**

Cases and concepts in educational administration. Prerequisite: Education 861. 3 credits.

**864. Practicum in Educational Administration**

Supervised practical experience in dealing with problems in educational administration. Prerequisite: Education 862. 3 credits.

**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. 3 credits.

**867. Legal Aspects of School Administration**

Legal aspects of school administration emphasizing federal and state laws which establish the duties, privileges, and responsibilities of school board members, superintendents, principals, 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. 3 credits.

**871. Principles of Personnel Services**

Examination of the theoretical foundations which influence the practical functioning of personnel services: counseling, guidance, measurement, administration, speech, hearing, reading, psychology, social work, consultation, research, health, placement and special education. 3 credits.

**872. Counseling Theory and Practice**

The art and science of counseling. The basic approaches to counseling are examined with emphasis upon their philosophical foundations. 3 credits.

**873. Psychology of Vocational Development**

Investigation of the psychological and informational factors which influence entrance into and movement within occupation. 3 credits.

**874. Organization and Administration of Personnel Services**

Investigation of the organizational patterns and administrative procedures which influence the effectiveness of personnel services programs. The elements of productive supervisory and staff relationships. Prerequisite: Education 871. 3 credits.

**875. Practicum in Counseling**

Supervised application of counseling theory and practice by involvement in role-playing experience. Prerequisite: Education 872. 3 credits.

**876. Counseling and Guidance in the Elementary School**

Application of the principles and procedures of counseling and guidance in meeting the developmental needs of the elementary school pupil. Prerequisite: Education 871 or 872. 3 credits.

**877. Group Counseling**

Investigation of counseling and guidance approaches as they apply in group situations. Group dynamics as it relates to counseling and guidance outcomes. Prerequisite: Education 872. 3 credits.

**878. Advanced Counseling Theory and Practice**

A detailed investigation of the counseling relationship: its characteristics, process, and outcomes. Prerequisite: Education 871 and 872. 3 credits.

**879. Advanced Practicum in Counseling**

Supervised application of advanced counseling theory and practice in involvement in actual counseling experiences. Verbatim samplings of counseling practice will be analyzed and evaluated. Inexperienced students may be assigned supervised field work. Prerequisite: Education 878. 3 credits.

**880. Research in Personnel Services**  
Investigation of research design and methodology in the personnel services. Prerequisite: Education 889. 3 credits.

**881. Methods and Techniques of Educational Research**

The principal quantitative methods employed in the investigation of educational problems. Prerequisite: Education 785 and permission of instructor. 3 credits.

**882. Research Problems in Education**

Prerequisite: permission of instructor. 2-6 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 757. 3 credits.

**886. Philosophy of Education**

Current educational objectives and practices and the philosophical foundations upon which they are based. Prerequisite: Education 757 and 759. 3 credits.

**887. The History of Educational Ideas**

All of the modern theories, practices, and present-day conflicts about education have their stems in the past. Some of

the scholarship of the social sciences as well as the materials from the history of education will be related to contemporary educational viewpoints. A better understanding of the bases of American ideas about education should result from this approach. 3 credits. (Extension and Summer Session only.)

**889. Psychological Tests in Personnel Services**

Study of those tests and evaluative instruments which have particular utility in the area of personnel services. Sample tests will be studied in order to determine their strengths and weaknesses. Prerequisite: Education 871, 872. 3 credits.

**890. Utilization of Testing in Public Education**

Methods of utilizing test data for predictive and analytical purposes in public schools. Emphasis given to problems of school-wide or community-wide magnitude. Prerequisite: Education 785. 3 credits.

**892. 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. A comparative approach is adopted; issues are examined cross-culturally and in relation to the schooling process. 3 credits.

**895, 896. Seminar in Contemporary Educational Issues and Practices**

A detailed analysis of selected contemporary educational issues and practices. Experimental projects that have explored the rationale, operational requirements, and effectiveness of these

practices and the practical considerations involved in the introduction of these practices into a local school system. Various sections will consider different educational practices and issues, e.g., team teaching, flexible scheduling, and the ungraded school. The subtitle indicates the specific area of study. Students may repeat the course for different areas of study. Prerequisite: teaching experience. 3-6 credits.

**899. Master's Thesis**  
3-9 credits.

### **Courses in Problems of Teaching High School Subjects**

These courses are offered by related academic departments.

The following courses are devoted to a study of problems of objectives, selection, and organization of subject matter, teaching and testing techniques, and classroom management in the teaching of the respective subjects. To be admitted into one of these courses the student must have completed, with a satisfactory grade, Education 758 or 858 and, in addition, the courses in the subject and related subjects designated as prerequisites to the respective courses in this group. A student who desires to be considered for supervised teaching must complete with a satisfactory grade one of these courses in the subject in which he hopes to do supervised teaching.

**Agriculture-Education 650. Principles of Agricultural Education**  
3 credits.

**Agriculture-Education 651, 652. Methods of Teaching Agricultural Mechanics**  
1 credit.

**Agriculture-Education (792). Planning for Teaching**  
4 credits

**Art-Education 791. Problems of Teaching Art in Secondary Schools**  
3 credits.

**Art-Education 792. Problems of Teaching Art in Elementary Schools**  
3 credits.

**Biology-Education 791. Problems in the Teaching of High-School Biology**  
3 credits.

**English-Education 791. Problems in the Teaching of High-School English**  
3 credits.

**French-Education 791. Problems of Teaching French**  
3 credits.

**History-Education 791. Problems in the Teaching of High-School History and Other Social Studies**  
3 credits.

**Home Economics-Education 791. Problems in the Teaching of High-School Home Economics**  
3 credits.

**Language-Education 791. Problems in the Teaching of Foreign Languages in the High School**  
3 credits.

**Mathematics-Education 791. Problems in the Teaching of High-School Mathematics**  
3 credits.

**Music-Education 791. Problems in the Teaching of Secondary School Music**  
3 credits.

**Music-Education 792. Problems in the Teaching of Elementary School Music**  
3 credits.

**Physical Education 792. Problems of Teaching Physical Education in the Elementary School**  
3 credits.

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## Electrical Engineering (83)

Joseph B. Murdoch, *Chairman*

H. Richard Skutt, *Graduate Adviser*

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To be admitted to graduate study in Electrical Engineering a student should have completed work in his major field equivalent to that currently required of undergraduates at the University of New Hampshire.

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

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

Permission of the instructor is required for enrollment in all Electrical Engineering graduate courses.

### 652. Industrial Electronics Fundamentals

Application of electronics to industrial processes. 2 lectures; 1 laboratory; 3 credits.

**706. Advanced Circuit Theory**  
Steady-state and transient analysis, derivation of fundamental formulas and constants, application of Laplace transforms. 3 credits.

### 712. Logical Design of Digital Computers

Generalized, systematic approach to the logical design of digital computers and related digital systems encompassing both theoretical and practical (laboratory) principles. Within the developed framework, the design of a general purpose computer will be formulated. Prerequisite: Electrical Engineering 611 or permission of instructor. 3 recitations; 1 laboratory; 4 credits.

### 725. Advanced Analysis of Alternating-Current Machinery

Steady-state and transient analysis of alternating and direct-current machines. 3 recitations; 1 laboratory or conference; 4 credits.

### 741. Fundamentals of Acoustics

The development of the acoustical wave equation for gases, solids, and liquids; reflection, refraction, and absorption; characteristics of acoustic sources; directivity of multi-source arrays; acoustical measurements and architectural acoustics; airborne noise control. Prerequisite: Physics 502 and Mathematics 527. 3 credits.

### 757. Communication Theory

Introduction to information theory; Fourier analysis, continuous and pulsed modulation; sampling, quantization; noise in electrical circuits. 3 credits.

### 758. Communication Systems

Application of communication theory and electronics to high frequency com-

munication system design. Modulators, R. F. amplification, receivers, antennas, free space propagation, ionospheric properties. Prerequisite: Electrical Engineering 509, 757, or equivalent. 3 recitations; 1 laboratory; 4 credits.

#### **762. Illumination**

Radiation, fundamental processes in gases, atomic spectra, sources of visible and near visible energy, lamp circuitry, illumination design, control of light, photometry, and color. 2 credits.

**Technology 780. Engineering Analysis**  
The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. 2-3 credits.

#### **781. Instrumentation**

Analysis and design of equipment for measurement, instrumentation, and control. 3 recitations; 1 laboratory; 4 credits.

#### **782. Control Systems**

Fundamental principles involved in the design and analysis of feedback control systems. 3 recitations; 1 laboratory; 4 credits.

#### **801. Field Theory**

The application of Maxwell's Equations to static and dynamic field problems. Introduction to the general wave equation in rectangular, cylindrical and spherical coordinate systems. 3 credits.

#### **802. Electromagnetic Wave Theory**

Advanced topics in electromagnetic field theory including waves in non-isotropic media and antenna characteristics. Prerequisite: Electrical Engineering 801. 3 credits.

#### **803. Principles of Microwave Systems**

Wave propagation in free space; dielectrics and conductors; normal modes of waveguides and cavities; interactions between traveling waves and electrons; generation at high frequencies. Pre-

requisite: Electrical Engineering 801. 3 credits.

#### **804. Antennas**

Theory and design of electromagnetic radiating systems. Prerequisite: Electrical Engineering 801. 3 credits.

#### **811. Fundamentals of Signal Processing**

Introductory probability theory, matrices and determinants, introductory graph theory. Laplace transforms and pole-zero concepts, complex-variable theory, convolution theorems. 3 credits.

#### **812. Network Synthesis**

Passive network synthesis techniques. Analysis and synthesis of integrated and thin-film structures. Active network synthesis methods. Prerequisite: Electrical Engineering 811. 3 credits.

#### **813. Nonlinear Networks**

Analysis of passive networks with nonlinear and time-varying parameters. 3 credits.

#### **814. Network Approximation**

Network design through approximation in the time and frequency domains. Prerequisite: Electrical Engineering 812. 3 credits.

#### **815. Linear Active Circuits**

Development of equivalent circuits for solid-state devices; analysis and design of linear networks containing these devices. 3 credits.

#### **816. Nonlinear Active Circuits**

Analytical and graphical techniques for circuits designed for pulse and other non-sinusoidal signals; and solid-state or vacuum-tube devices used in the switching mode. 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 func-

tions; Fourier and Hilbert transforms; time-and-frequency domain correlation. Prerequisite: Electrical Engineering 811. 3 credits.

### **821. Transmission and Distribution of Electric Power**

Line characteristics, steady-state performance, symmetrical components, lightning and over-current protection, relaying. 3 recitations; 1 laboratory or conference; 4 credits.

### **831. Semiconductor Electronics**

A study of topics in solid-state electronics including semiconductor physics, theory of semiconductor devices, bulk effects, semiconductor technology, and selected applications. Prerequisite: Electrical Engineering 609. 3 credits.

### **839. Statistical Theory of Communications**

Harmonic analyses of periodic, aperiodic and random functions. Probability, correlation, power density spectra, sampling theory, detection of periodic signals in noise, and optimum filtering. 3 credits.

### **840. Information Theory**

Discrete and continuous probability, fundamentals of encoding, basic information theory and stochastic processes. 3 credits.

### **851. Advanced Control Systems I**

Advanced topics in analysis and design of linear and non-linear feedback control systems. Prerequisite: Electrical Engineering 782. 3 credits.

### **852. Advanced Control Systems II**

Special topics in control theory; such as multivariate, optimal, adaptive, and other state-of-the-art control topics. 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 712. 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.

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## **English (49)**

John C. Richardson, *Chairman*

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The Department of English offers two advanced degrees, the Master of Arts and the Master of Science for Teachers. The Master of Science for Teachers is a terminal degree, one designed for the high school teacher. The Master of Arts is, primarily, the first step to the doctoral degree; the candidate will ordinarily be preparing for teaching in a college or university.

For the Master of Arts degree, a reading knowledge of French, German, or Latin is required of the candidate. For the Master of Science for Teachers degree, no foreign language is required. The student who is a candidate for the degree of Master of Science for Teachers must take 30 hours of work in English numbered above 700 that will not be a repetition of his undergraduate course work.

The student who is a candidate for the Master of Arts degree must earn 30 credits: no more than 12 in literature courses numbered 750-800; 12 in literature courses numbered 850-898 (6 of which must be in graduate seminars: 885-898); and 6 credits in a thesis (899).

A student taking a course numbered 850-884, though attending the undergraduate lectures, must do additional work assigned by his instructor and prepare a paper on an agreed subject connected with his study.

All graduate students, even though they attend undergraduate classes, are market on the graduate level.

If a student intends to complete his work for the Master of Arts degree in one year, he should register for three thesis credits each semester. The complete first draft of the thesis must be submitted to the thesis director at least two months before the degree is to be granted. The final copies must be ready for signing by the thesis director and two other readers at least three weeks before the degree is to be granted.

**701, 702. Advanced Writing of Fiction and Poetry**

Mr. Williams. Prerequisite: permission of instructor. 3 credits.

**703, 704. Writing Non-Fiction**

Mr. Murray. Prerequisite: permission of instructor. 3 credits.

**705. English Grammar**

Mr. Goffe. 3 credits.

**709, 710, 711. Critical Analysis**

Analysis of three forms of writing: 709, exposition; 710, fiction; 711, poetry. Mr. Bingham and Mr. Richardson.

**(751). History of the English Language**

Mr. Carnicelli. 3 credits.

**753. Old English**

Mr. Carnicelli. 3 credits.

**754. Beowulf**

Mr. Carnicelli. 3 credits.

**755, 756. Chaucer**

Mr. Underwood. 3 credits.

**757, 758. Shakespeare's Plays**  
Mr. Hapgood. 3 credits.

**759. Milton**

3 credits.

**760. Boswell's Johnson**

3 credits. (Not offered in 1968-1969.)

**761. Wordsworth**

Mr. Miller. 3 credits.

**762. Browning**

3 credits. (Not offered in 1968-1969.)

**763, 764. English Literature in the Sixteenth Century**

3 credits.

**765, 766. English Literature in the Seventeenth Century**

Mr. Underwood. 3 credits.

**767, 768. English Literature in the Eighteenth Century**

Mr. Maynard. 3 credits.

**769, 770. The English Romantic Period**

Mr. Miller. 3 credits.

**771, 772. Victorian Prose and Poetry**

Mr. Miller. 3 credits. (Not offered in 1968-1969.)

**773, 774. British Literature of the Twentieth Century**

Mr. Daggett and Mr. Richardson. 3 credits.

**775. New England Renaissance**

Emerson, Thoreau, and other transcendentalists. Mr. Daggett. 3 credits.

**776. American Novel in the Nineteenth Century**

Mr. Goffe. 3 credits.



777. American Poetry of the Nineteenth Century  
Mr. Daggett. 3 credits. (Not offered in 1968-1969.)

779, 780. American Literature of the Twentieth Century  
Mr. Nicoloff. 3 credits.

781, 782. Introduction to English Drama  
Mr. Haggood. 3 credits.

783, 784. The English Novel of the Eighteenth and Nineteenth Centuries  
Mr. Bingham and Mr. Miller. 3 credits.

(851). History of the English Language  
3 credits.

853. Old English  
3 credits.

854. Beowulf  
3 credits.

855, 856. Chaucer  
3 credits.

857, 858. Shakespeare's Plays  
3 credits.

859. Milton  
3 credits.

860. Boswell's Johnson  
3 credits. (Not offered in 1968-1969.)

861. Wordsworth  
3 credits.

862. Browning  
3 credits. (Not offered in 1968-1969.)

863, 864. English Literature in the Sixteenth Century  
3 credits.

865, 866. English Literature in the Seventeenth Century  
3 credits.

867, 868. English Literature in the Eighteenth Century  
3 credits.

869, 870. The English Romantic Period  
3 credits.

871, 872. Victorian Prose and Poetry  
3 credits. (Not offered in 1968-1969.)

873, 874. British Literature of the Twentieth Century  
3 credits.

875. The New England Renaissance  
3 credits.

876. The American Novel in the Nineteenth Century  
3 credits.

877. American Poetry of the Nineteenth Century  
3 credits. (Not offered in 1968-1969.)

879, 880. American Literature of the Twentieth Century  
3 credits.

881, 882. An Introduction to English Drama  
3 credits.

883, 884. The English Novel of the Eighteenth and Nineteenth Centuries  
3 credits.

885, 886. Seminar — Problems in Medieval Literature  
Mr. Underwood. 3 credits. (886 not offered in 1968-1969.)

887. Seminar — Studies in Sixteenth-Century Literature  
3 credits. (Not offered in 1968-1969.)

888. Seminar — Problems in Milton Scholarship and Criticism  
3 credits.

889. Seminar — Studies in Shakespeare  
Mr. Hapgood. 3 credits.

890. Seminar — Studies in English Drama  
Mr. Hapgood. 3 credits.

892. Seminar — Studies in Restoration Literature  
Mr. Underwood. 3 credits.

893. Seminar — Studies in Early Seventeenth-Century Literature  
3 credits.

895. Seminar — Studies in American Literature of the Nineteenth Century  
3 credits.

899. Master's Thesis  
6 credits.

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## Entomology (29)

James G. Conklin, *Chairman*

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For admission to graduate study in Entomology an applicant is expected to have had adequate preparation in undergraduate Entomology and related sciences. Students lacking the necessary background courses may be required to complete certain courses which do not carry graduate credit before they are admitted to candidacy for a degree. The program of graduate study is designed to meet the needs of those students who are planning to take further work leading to a career in professional entomology.

A thesis is required of all candidates for the Master'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; 3 credits.

**707-708. Advanced Entomology**  
The anatomy and physiology of insects. Systematic entomology. Mr. Conklin and Mr. Blickle. Open to others than Entomology majors by permission of Department Chairman. 2 lectures; 2 laboratories; 4 credits.

**709-710. Advanced Economic Entomology**  
Problems in applied Entomology; the literature of economic entomology. Investigational methods. Studies of the specialized phases of entomology. Mr. Conklin and Mr. Blickle. Required of Entomology majors. Open to others than Entomology majors by permission of Department Chairman. 1 to 3 credits.

**801, 802. Graduate Entomology**  
Mr. Conklin and Mr. Blickle. Hours and credits to be arranged.

**899, (899). Graduate Entomology. Master's Thesis**  
Mr. Conklin, Mr. Blickle, and Mr. Reeves. Hours and credits to be arranged. 6-10 credits.

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## Forest Resources (30)

Paul E. Bruns, *Chairman*

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Students admitted to graduate study in Forestry are expected to have completed a course of study equivalent to that required for the degree of Bachelor of Science in Forestry. Those who lack undergraduate training in any of the necessary fields may be required to complete certain courses in these subjects without graduate credit before being admitted to candidacy for a degree. Candidates for the Master's degree in Forestry must pass an oral examination. A thesis may or may not be required.

### **711. Statistical Methods II**

An intermediate course in statistics. Topics include basic concepts of sampling, linear models and analyses for one-way and multiway classifications, factorial arrangement of treatments, multiple regression, and covariance. Prerequisite: Forest Resources 528 or equivalent. 3 credits.

### **730. Forest Tree Improvement**

A consideration of 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. (Alternate years; not offered in 1968-1969.) 2 lectures; 1 laboratory; 3 credits.

### **734. Forest Fish and Game**

Fish and wildlife population dynamics and the theory of game management. The characteristics of important game species and management techniques useful in the northeastern forest habitat. Elective with permission of instructor. Mr. Olson. 3 lectures; 1 laboratory; 4 credits.

### **746. Forest Resources Seminar**

Case studies of forest land units. Population trends and human needs in relation to forest land productivity for timber, wildlife, water, recreation and grazing. Organized groups involved in forest land use and management, and overall planning to help maximize forest land use and productivity for our society will be studied. Mr. Wallace. Prerequisite: Forest Resources 661. 4 credits.

### **755, 756. Forest Wildlife Management**

Readings and discussions on the properties of wildlife species and the various phases of management including public relations, law enforcement and control of undesirable species. Students should be prepared to participate in

week-end field trips to game management areas in New England. Mr. Olson. Prerequisite: Forest Resources 734 or permission of instructor. 2 lectures; 1 laboratory; 3 credits.

**758. Photogrammetry in Forestry**  
Elementary principles of photogrammetry with emphasis on their application to all phases of forestry. The value and use of aerial photos in forest typing, planimetric, and topographic mapping; measurement of area and volume estimation. Prerequisite: permission of instructor. 2 lectures; 1 laboratory, 3 credits.

### **763. 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. 2 1/2-hour sessions; 3 credits.

### **764. Forest Industry Economics**

Application of business methods and economics in the establishment and operation of forest industries; planning for minimum cost operations and the profitable use of capital in forest enterprises. Mr. Wallace. Prerequisite: senior standing and permission of instructor. 2 lectures; 1 laboratory; 3 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.

### **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 problem analyses, working plans, and the preparation of reports. Mr. Foster 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.

#### **806. Logging Economics Seminar**

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of raw material procurement. Mr. Foster. 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. 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: permission of instructor. 2 lectures; 1 laboratory; 3 credits.

#### **818. Advanced Photogrammetry in Forestry**

The application of aerial photogrammetrical techniques to specific forestry problems. The use of photographs for volume estimation including cull, volume tables, and species composition; use in fire control, range, timber and recreational management, road location, allocation of cut, and in designing large-

scale resource inventories. Prerequisite: permission of instructor. 2 credits.

**833. Forest Protection Seminar**  
Discussion and special problems based on principles and techniques of forest protection. Mr. Weyrick. Prerequisite: Forest Resources 660 or equivalent. 3 credits.

**861, 862. Investigations in (1) Forest Ecology, (2) Photogrammetry, (3) Wood Utilization, (4) Game Management, (5) Mensuration, (6) Forest Economics, (7) Forest Management, (8) Logging Economics**  
Work to be arranged according to the needs of individual students. Staff. Hours to be arranged. Prerequisite: permission of instructor. 2-4 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.

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## **French and Italian**

Samuel E. Stokes, Jr., *Chairman*

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The Department of French and Italian offers courses leading to two degrees, Master of Arts and Master of Science for Teachers in French.

To be admitted to graduate study for the Master of Arts degree, a student must have completed an undergraduate major in French or the equivalent thereof. He must also submit scores of the Graduate Record Examination, both the Aptitude Test and the Advanced Test in French.

To satisfy course requirements for the degree, the student must complete at least 30 credits; 24 in course work and 6 for the Master's thesis. 18 of the course credits must be in French courses, 12 in French courses numbered 800 or above. 6 of the 24 course credits may

be taken in related departments. The thesis must embody results of independent investigation and be written in a form acceptable to the Department. It must be submitted to the thesis director before April 20 of the academic year in which the degree is to be granted. To be admitted to graduate study for the Master of Science for Teachers degree in French, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in that language. To satisfy course requirements for the degree, the student must complete at least 30 credits: 24 must be in French courses, 12 in French courses numbered 800 or above; 6 of the credits may be taken in related departments; and 6 may be transferred from an accredited NDEA institute granting graduate credits. The candidate for the degree must pass a departmental oral and written examination on or before April 20 of the academic year in which the degree is to be granted.

## **French (56)**

### **741. French Literature of the Middle Ages**

Readings in the epic, lyric poetry and the romance. Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

### **742. French Literature of the Renaissance**

Rabelais, Marguerite de Navarre, Ronsard, Du Bellay, Montaigne and others. Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

### **759-760. French Literature of the Seventeenth Century**

759: Historical and literary background of French classicism, poetry, Corneille. Pascal, and Molière's early plays. 760: Molière. Racine, LaFontaine, Mme. de LaFayette, Boileau, and LaBruyère.

Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

### **761-762. Eighteenth Century French Literature and Thought**

761: Precursors of Age of Enlightenment — Bayle, Fontenelle, Montesquieu; Voltaire's early works; Marivaux and others. 762: Diderot, Encyclopedists, later Voltaire, Laclous, Rousseau and others. Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

### **767-768. Nineteenth Century French Literature**

767: Romanticism; Mme. de Stael, Chateaubriand, Stendahl, Lamartine, Hugo, Vigny, Musset. 768: Late Romanticism; Realism; Balzac, Flaubert, Hugo, the Parnassian school. Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

### **(770). Introduction to Modern French Poetry**

Baudelaire, Rimbaud, Mallarmé, Valéry, and others. Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

### **781-782. Contemporary French Novel and Theater**

781: Maeterlinck, Vildrac, Apollinaire, Gide, Proust, Mauriac and others. 782: Malraux, Bernanos, Sartre, Camus, Anouilh, Giraudoux and others. Conducted in French. Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

**788. Seminar in French Literature**  
A study of French authors at the discretion of the instructor. Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**790. Advanced Language and Style**  
Translation of literary texts, intensive study of the principal techniques of style.

*explication de textes*. Open to qualified students who have had a minimum of six hours of French courses numbered 641 and above. 3 credits.

**795, 796. Special Studies in French Language and Literature**

Individual guided study in special topics, with training in bibliography and organization of material. Examples of topics which may be selected are: the work of a major French author, specific topics in any area of French literature, such as literary criticism in the Seventeenth Century. Staff. Prerequisite: permission of Department Chairman. Variable credit.

**841. French Literature of the Middle Ages**

Prerequisite: French. 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**842. French Literature of the Renaissance**

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**859-860. French Literature of the Seventeenth Century**

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

**861-862. Eighteenth Century French Literature**

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

**867-868. Nineteenth Century French Literature**

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**(870). Introduction to Modern French Poetry**

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**881-882. Contemporary French Novel and Theater**

Prerequisite: French 606. 3 credits. (Alternate years; offered in 1968-1969.)

**888. Seminar in French Literature**

Prerequisite: French 606. 3 credits. (Alternate years; not offered in 1968-1969.)

**890. Advanced Language and Style**

Prerequisite: open to qualified students who have had a minimum of six hours of French courses numbered 641 and above. 3 credits.

**895, 896. Special Studies in French Language and Literature**

Prerequisite: permission of Department Chairman. Variable credit.

**899. Master's Thesis**

6 credits.

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## Genetics Program (97)

Frank K. Hoornbeek, *Chairman*

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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 chairman of the department in which he has a major interest. Students will be expected to have adequate preparation in the biological and physical sciences including mathematics. Students lacking these requirements may be admitted but will be required to complete certain courses without graduate credit.

The Program is conducted by faculty members from the departments of Animal Sciences, Biochemistry, Botany, Forest Resources, Microbiology, Plant Science, and Zoology as well as other faculty from the Agricultural Experiment Station and the U. S. Forest Service Northeastern Forest Experiment Station. Areas of specialization in the program

are: the genetics of plants, animals, microorganisms, and viruses.

### **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 and pass an oral examination covering his graduate courses and thesis.

### **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. Specific course requirements will be developed by the student and his guidance committee. Students must complete a dissertation on original research in genetics.

A student must satisfy the foreign language requirement by either (a) demonstrating a reading knowledge of two foreign languages or (b) demonstrating high proficiency in one language. Satisfaction by either (a) or (b) may be by prior or concurrent formal training, or examination, as determined by the student's guidance committee. High proficiency is judged (1) as completion of three years' formal training in a language or (2) from examination by a committee-appointed examiner.

### **Courses Available in the Genetics Program**

#### **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 411 or permission of instructor. 3 credits. (Alternate years; not offered in 1968-1969.)

**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 411 or permission of instructor. 3 credits. (Alternate years; offered in 1968-1969.)

#### **821. Biometrical Genetics**

Statistical aspects of estimating genetic parameters associated with quantitative traits. The theory underlying estimation of components of variance from various experimental designs, phenotypic and genotypic correlations, construction of selection indices, and the use of collateral and ancestral relatives to estimate breeding value. Mr. Urban. Prerequisite: Genetics 812, Mathematics 411 and either Animal Science 703 or Plant Science 774. 3 credits. (Alternate years; not offered in 1968-1969.)

**(898), 898. Genetics Seminar**  
Presentation and discussion of selected genetic topics. Staff. 1 credit. May be repeated.

**899, (899). Master's Thesis**  
6-10 credits.

**999, (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 (25)**

##### **703. Animal Genetics**

Mendelian and quantitative inheritance in animals, principles and systems of selection. Mr. Collins. Prerequisite: 3 credits of genetics or permission of

instructor. 2 lectures; 1 laboratory; 3 credits.

### **812. Quantitative Genetics and Animal Improvement**

Gene frequency, genetic and environmental variation, heritability, fitness, selection, inbreeding, outbreeding, correlated characters. Mr. Collins. Prerequisite: 3 credits each of genetics and statistics. 3 credits.

### **Biochemistry (26)**

#### **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 756 or permission of instructor. 2 credits.

#### **772. Biochemical Genetics**

##### **Laboratory**

Experimental techniques applicable to the study of genetics at the biochemical level. To be taken in conjunction with Biochemistry 770. 2 laboratories, 2 credits.

### **Botany (27)**

#### **754. Cytology**

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

#### **764. Microtechnique**

Methods of embedding, sectioning, and staining plant tissues, and introduction to microscopy. Miss Nast. Prerequisite: Botany 411 or 503. 3 credits.

### **Forest Resources (30)**

#### **711. Statistical Methods II**

An intermediate course in statistics. Topics include basic concepts of sampling, linear models and analyses for one-way and multiway classifications, factorial arrangement of treatments,

multiple regression, and covariance. Prerequisite: Forest Resources 528 or equivalent. 3 credits.

### **730. 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, 3 credits. (Alternate years; not offered in 1968-1969.)

### **Microbiology (47)**

#### **803. Microbial Cytology**

The fine structure of bacteria and related organisms (Procaryotic 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; 2 laboratories; 4 credits.

#### **804. Microbial Genetics**

An introduction to genetic principles and methodology applicable to microorganisms; fine structure of genetic material, mutation, selection, adaptation, recombination, transformation, and transduction. Mr. Hickson. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

### **Plant Science (32)**

#### **774. Methods and Theory of Plant Breeding**

History and use of plant breeding systems, including bulk and pedigree methods, recurrent selection, gamete selection, and testing. Mr. Peirce. Prerequisite: 3 credits in genetics. 3 credits. (Alternate years; not offered in 1968-1969.)



### 832. Developmental Genetics

Relation to protein, RNA, and DNA synthesis in development, chromosome differentiation, nuclear-cytoplasmic interactions, genic and non-genic control of subcellular organization, cellular continuity, cell associations, experimental embryology, hormones and post-embryonic development, gene regulation in development, and neoplastic growth. Mr. Loy. Prerequisite: permission of instructor. 3 credits. (Spring, alternate years; offered in 1968-1969.)

### 851. Plant Genetics

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation and genetics of disease resistance. Mr. Dunn. Prerequisite: Zoology 706 or equivalent. 3 credits. (Alternate years; not offered in 1968-1969.)

### 853. Cytogenetics

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory technique in cytogenetic analysis. Mr. Rogers. Prerequisite: 3 credits each in genetics and cytology. 2 lectures; 1 laboratory; 3 credits. (Alternate years; offered in 1968-1969.)

## Zoology (70)

### (706), 706. Genetics

A general course in the principles of genetics. Includes basic Mendelism, linkage, quantitative variation, mutation and population genetics. Introduces the chemical basis of heredity, action of the gene and application of Mendelian principles to animal and plant breeding. Mr. Hoornbeek. Prerequisite: Zoology 412 or equivalent. 3 credits. Laboratory optional for non-majors for one additional credit, but required of Zoology majors.

### 836. Advanced Genetics

Genetic recombinations and mutations. Structure and logical action of the gene. Mr. Hoornbeek. Prerequisite: Zoology 706 or equivalent. 3 credits.

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## Geology

Herbert Tischler, *Chairman*

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Admission to graduate study in Geology will be granted to applicants who have had adequate preparation in the geological and cognate sciences. Students lacking these requirements may be admitted, but will be required to complete certain courses which do not give graduate credit. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and his thesis.

### 716. Mineralogy of Clays

The composition of various types of clays; the structure and properties of clay minerals; the origin and mode of occurrence of the clay minerals and clay materials; the utilization of clays in the arts and industry. Mr. Gaudette. Prerequisite: Geology 613, 512 or permission of instructor. 3 credits.

### 725. Igneous and Metamorphic Petrography

Igneous and metamorphic rocks in thin section; the optical identification of minerals and the significance of texture; the application of experimental petrology to petrogenesis. Mr. Bothner. Prerequisite: Geology 615, 622 or permission of instructor. 2 lectures; 1 laboratory; 3 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: Geology 613 or permission of instructor. 3 credits.

### 754. Sedimentology

The properties of sediments and sedimentary rocks, the sedimentary processes and environments, correlation procedures

and stratigraphic principles. Mr. Anderson and Mr. Tischler. Prerequisite: Geology 401 and 512 or permission of instructor. 2 lectures; 1 laboratory; 3 credits.

#### **759. Geological Oceanography**

The interaction between the marine and terrestrial environments; special emphasis on bathymetric features, continental shelf sedimentation, deep sea sedimentation, and the discussion of recent marine geological hypotheses. Mr. Anderson. Prerequisite: Geology 501 and 754 or permission of instructor. 2 lectures; 1 discussion period; 3 credits.

#### **771-772. Economic Geology**

First semester: the types of coal and their occurrence in the United States; petroleum, the structures in which it is found and the distribution and geology of oil fields, especially in the United States; industrial minerals and their utilization. Second semester: the metals, their ores, and the geology of important ore deposits. Mr. Meyers. Prerequisite: Geology 512. 3 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. For high school science teachers who need an introduction to the earth sciences. (Not available for credit after completing Geology 401 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: Geology 781 or equivalent. For high school science teachers who need an introduction to the earth sciences. (Not available for credit after

completing Geology 402 or equivalent.) 4 credits.

#### **795. Geological Problems**

Special problems by means of conferences, assigned readings, and field or laboratory work, fitted to individual needs from one of the areas listed below. Staff. Prerequisite: permission of instructor. 1-2 credits. This course may be repeated to a total of not more than 5 credits.

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

#### **797. Geology Seminar**

Study of selected topics in both classical and modern geological thought. Prerequisite: senior standing and permission of instructor. 2 credits.

#### **895, 896. Topics in Geology**

An opportunity for advanced work on an individual or group basis. Prerequisite: permission of department chairman and staff concerned. 1-4 credits. Sections of this course are the same as those listed under Geology 795. May be repeated.

#### **897, 898. Seminar in Contemporary Geology**

A review and discussion of recent geological literature. The instructor, the format, and the content will vary

from year to year. Prerequisite: permission of department chairman and staff concerned. May be repeated. 1-3 credits.

**899. Master's Thesis**  
6-10 credits.

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## German and Russian

Hermann W. Reske, *Chairman*

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The Department of German and Russian offers programs leading to the degrees of Master of Arts and Master of Science in Teaching (both degrees in German only).

To be admitted to graduate study for either degree, a student must have met requirements substantially equal to those set up for an undergraduate major in German.

To satisfy requirements for the degree of Master of Science in Teaching of German, the candidate must complete at least 30 credits of approved graduate work. At least three credits must be selected from the seminars listed below; one seminar paper will be required. The candidate for the degree must pass the departmental comprehensive written examination.

To satisfy requirements for the degree of Master of Arts in German, the candidate must pass the departmental comprehensive written examination and *either*:

(a) complete 30 credits of graduate course work with at least three credits selected from the list of seminars; one seminar paper will be required, *or*  
(b) complete 24 credits of graduate course work and write a thesis. (Six credits are awarded for the thesis, thus completing the total 30 credits established by the Graduate School as requisite for the degree.) The departmental comprehensive written examination must be passed before the student undertakes work on the thesis. If the student takes the examination in German,

he may write the thesis in English; if he takes the examination in English, he must write the thesis in German. If he wants to do both in German, he may do so. The thesis 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 five weeks before the date the degree is to be granted.

A candidate will be permitted to take the departmental comprehensive written examination only twice. If he fails in his first attempt, he must wait at least three months before taking it again.

### German (57)

#### 701. Intermediate Composition

A systematic study of style, shades of meaning, adequacy of expression. A thorough knowledge of German grammar is prerequisite. Practice in writing seminar papers and obtaining stylistic flexibility in the use of written German. Prerequisite: German 501. (Summer Session only.) 2 credits.

#### 703. Intermediate Oral Practice

For students with a fair knowledge of spoken German but who will need more fluency and accuracy of expression. Prerequisite: German 507. (Summer Session only.) 2 credits.

#### 705. Advanced Oral Practice

An intensive course in oral self-expression. Small groups only. Very detailed program for each lecture on assigned subjects. Prerequisite: German 703. (Summer Session only.) 2 credits.

#### 707. Practical Phonetics

The sound and rhythm of spoken German. Classroom discussions are supplemented by intensive use of the Language Laboratory. (Summer Session only.) 2 credits.

#### 755. German Literature of the Age of the Baroque

German literature between Reformation and the Age of Enlightenment. Reading,

interpretation, and critical analysis of prescribed prose, drama, and poetry with emphasis on the philosophical and social ideas of the time. Prerequisite: German 605-606. 3 credits. (Alternate years.)

**756. German Literature of the Age of Enlightenment**

German literature from the Baroque period to the beginning of the period of Storm and Stress with emphasis on readings and interpretations of works of Lessing and Wieland. Prerequisite: German 605-606. 3 credits. (Alternate years.)

**757-758. The Age of Goethe**

German literature of Storm and Stress and the Classical Period. Interpretation and critical analysis with emphasis upon selected works of Wagner, Klinger, Lenz, Schiller, and Goethe. Prerequisite: German 606. 3 credits. (Alternate years.)

**759-760. German Romanticism**

German literature from the end of the Eighteenth Century to 1830. Interpretation and critical analysis of prescribed prose, drama, and poetry of prominent writers and poets of the period, from Wackenroder to Eichendorff. Prerequisite: German 606. 3 credits. (Alternate years.)

**761-762. The Age of Realism**

Representative German writers, dramatists, poets, and novelists from the end of Romanticism to the beginning of Naturalism (1830-1880) will be read and discussed with a background of social and philosophical development. Prerequisite: German 606. 3 credits. (Alternate years.)

**763-764. German Literature since 1880**

From Naturalism to the present. Reading, interpretation, and critical analysis of prescribed prose, drama and poetry of Hauptmann, Hofmannsthal, Rilke, Mann, Kafka. Prerequisite: German 606. 3 credits. (Alternate years.)

**781. History and Development of the German Language**

An insight into the history and development of the German language. Beginning with the Indo-European Period, it traces the changes in sounds, structure, and vocabulary to the establishment of modern German. Prerequisite: German 605-606. 3 credits.

**782. Advanced Stylistics**

A systematic study of style, shades of meaning, adequacy of expression. A thorough knowledge of German grammar is prerequisite. Practice in writing seminar papers and obtaining stylistic flexibility in the use of written German. Prerequisite: German 605-606. 3 credits.

**791. Methods of the Teaching of German**

Modern language teaching on all levels from high school to college. The course emphasizes the practical approach of teaching and the use of modern equipment such as audio-visual aids, tape recorders, films, records, etc. Especially tailored for teachers of German in high school and colleges. 2 or 3 credits.

**795, 796. Special Studies in German Literature**

Individual guided study in special topics, with training in bibliography, note taking, organization of material. Examples of topics which may be selected by instructor and student in conference are: (1) Wolfram von Eschenbach: Parzival; (2) Walther von der Vogelweide: Lyrics; (3) Middle High German Popular Epics; (4) German Literature of the 17th Century; (5) Goethe's Poetry; (6) Goethe's Faust; (7) Heinrich v. Kleist; (8) German Romanticism; (9) 20th Century German Literature. Prerequisite: permission of department chairman. Variable credit.

**831. German Culture I, History**  
(Summer Session only.) 2 credits.

- 832. German Culture II, Art**  
(Summer Session only.) 2 credits.
- 833. German Culture III, Folklore**  
(Summer Session only.) 2 credits.
- 855. German Literature of the Age of the Baroque**  
3 credits. (Alternate years.)
- 856. German Literature of the Age of Enlightenment**  
3 credits. (Alternate years.)
- 857-858. The Age of Goethe**  
3 credits. (Alternate years.)
- 859-860. German Romanticism**  
3 credits. (Alternate years.)
- 861-862. The Age of Realism**  
3 credits. (Alternate years.)
- 863-864. German Literature since 1880**  
3 credits. (Alternate years.)
- 881. History and Development of the German Language**  
3 credits.
- 882. Advanced Stylistics**  
3 credits.
- 883. Seminar: History and Development of the German Language**  
Prerequisite: German 881. (Summer Session only.) 2 credits.
- 885. Seminar: Masterpieces of the Age of Enlightenment**  
Mrs. Lawson. 3 credits.
- 886. Seminar: Masterpieces of the Age of Goethe**  
Mr. Reske. 3 credits.
- 887. Seminar: Masterpieces of the 19th Century German Literature**  
Mrs. Lawson. 3 credits.

**888. Seminar: Masterpieces of German Literature after 1880**  
Mr. Brandt. 3 credits.

**895, 896. Special Studies in German Literature**  
Prerequisite: permission of department chairman. Variable credit.

**899. Master's Thesis**  
6 credits.

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## History (53)

William R. Jones, *Chairman*

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In general, the candidate for admission to graduate study in History should present evidence of having satisfactorily completed at least 24 semester credits as an undergraduate in courses in History, not including courses open to freshmen, with a grade of C or better. The History Department, however, reserves the right to judge each applicant on his individual merits. The requirements for the degree of Master of Arts in History are those on pages 21 to 22 of this catalog. The completed thesis must be submitted by April 1 of the year in which the degree is to be granted. A final examination is not required.

**707, 708. Colonial and Revolutionary American History**  
Colonial beginnings in America, national rivalries, the English colonies, the Revolution, and our national life to 1789. Early forms of Americanism in the making. Mr. Gilmore. 3 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. 3 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. 3 credits.

**719, 720. The Foreign Relations of the United States**

Primarily the history of American diplomacy, with attention given to the non-diplomatic aspects of foreign relations. Mr. Long. 3 credits.

**721, 722. Social and Intellectual History of the United States**

The development of American thought and society, with emphasis on the relationship between ideas and events. The first semester, approximately one-half of which is devoted to the period before the American Revolution, covers topics of fundamental importance to the growth of American civilization from the beginning of English settlement to the eve of the Civil War. The second semester deals with similar topics and issues during the period from the Civil War to the present. Mr. Clark. 3 credits.

**723. American Historiography**

The principal writings of American historians from the 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. 3 credits.

**725. Business History**

The development of business enterprise and its institutions in Western Europe and the United States from the late Middle Ages to the era of the giant diversified corporation. The role of the entrepreneur, the impact of public policy on business, and the case study of individual firms. Mr. Greenleaf. 3 credits. (Offered in the Whittemore School as

Business Administration 725 and Economics 725.)

**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. 3 credits.

**743. Renaissance and Reformation**

The history of Europe during the fifteenth and sixteenth centuries with primary emphasis on the Italian Renaissance, the Protestant Reformation, and the emergence of the national state. 3 credits.

**747. The Age of Absolutism**

The theory and practice of absolutism from its origin in the seventeenth century to its apogee in enlightened despotism. 3 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. 3 credits.

**756. Twentieth Century Europe**

European history in the twentieth century will be treated from the point of view of a civilization in a constant state of crisis. World War I, the inter-war period, World War II, and the attempts to solve the conflicts of modern society after that war in terms of new economic, political, and cultural patterns will represent the core of the study. The effects of extra-European influences, the loss of European primacy, and continued strife within the structure of the European state and cultural system. Mr. Heilbronner. 3 credits.

**759. History of Modern Spain and Portugal**

The Iberian states and their peoples from the coming of nineteenth century liberalism to the present. Political and social change will be emphasized but attention will be paid to imperial activity as well as to intellectual movements. External influences of European thought and activity will be considered as relevant to the study of two modernizing countries with persistent traditions. Mr. Wheeler. 3 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 death of Queen Anne. Mr. Schwarz. 3 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. 3 credits.

**767, 768. History of Germany**

Germany and the various German states from the Peace of Westphalia in 1648 to the Third Reich and the presently divided Germany. The course will emphasize the relationship and importance of Germany to the rest of Europe. Mr. Lentz. 3 credits.

**774. European Historiography**

An examination of selected works of historical literature since the Reformation. Emphasis will be placed on the comparison of different schools of historical interpretation, the development of historical method, and the impact of Romanticism, Idealism, Nationalism, and Positivism on the composition of historical literature. 3 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. Miss James. 3 credits.

**(781). History of Modern China, 1850-1950**

The modernization of China. The political, social, and cultural changes which have occurred in China from its early contacts with the West to the establishment of the Communist Regime. Mr. Linden. 3 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. With special attention 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. 3 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. 3 credits.

**(789). Seminar in the History of Science**

Selected topics, conducted through special lectures, individual study, 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. Schneer. Prerequisite: permission of adviser and instructor. 3 credits.

**791. History-Education (Hist-Ed). 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 401, 402; six credits from American Government, Principles of Economics, or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. Mr. Draves. 3 credits.

**792. Advanced Study in the Teaching of World History**  
6 credits. (Summer Session only.) Admission limited to in-service high school teachers with permission of the Department of History.

**(793). World History**

History from the perspective of the experience of the whole human 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. Prerequisite: permission of instructor. Mr. Voll. 3 credits.

**807, 808. Sources for the Study of Colonial American History**

For students who have taken Colonial and Revolutionary American History or the equivalent. Training in the methods of historical investigation and in the use of sources in the field of colonial American history. The preparation of papers based on source materials alone. Mr. Gilmore. Prerequisite: permission of instructor. 3 credits.

**811, 812. Seminar in Nineteenth Century American History**

For students interested in examining in depth certain significant conditions, trends, and aspects of American society during the nineteenth century. Mr. Jellison. Prerequisite: a course in United States history and permission of instructor. 3 credits.

**815, 816. Seminar in Twentieth Century American History**

A specialized and analytical study of movements, institutions, personalities, and problems which have played a shaping role in the development of the United States between 1896 and the middle of the twentieth century. Research papers pertinent to seminar discussions will be required. Mr. Greenleaf. Prerequisite: a course in United States history and permission of instructor. 3 credits.

**821, 822. Seminar in the Social and Intellectual History of the United States**

Selected topics in American thought, culture, and social history. The techniques of research in primary materials, and includes a grounding in the historiography of the topic under discussion. Each student must produce a major research paper. The topic for the first semester will ordinarily be chosen



from the seventeenth century; for the second semester, from the nineteenth or twentieth century. Mr. Clark. 3 credits.

### 835, 836. Seminar in Modern European History

Specialization in the study of the development of some major institutions and ideas which contributed to the structure and spirit of modern society. Research papers, relating to seminar discussions, will be required. Prerequisite: a course in modern European history and permission of instructor. 3 credits.

### 861, 862. Seminar in the History of England in the Tudor and Stuart Periods

A consideration, and research in, selected topics with particular emphasis on the English Reformation and the Puritan Revolution. Prerequisite: a course in English history and/or permission of instructor. Mr. Schwarz. 3 credits.

### 863, 864. Seminar in Russian History

The seminar will be concerned with the study of, and research in, specific, limited topics in nineteenth and twentieth century Imperial and Soviet history. Mr. Heilbronner. Prerequisite: a course in Russian history and permission of instructor. 3 credits.

### 895, 896. Reading and Research in History:

(1) American Colonial History, (2) United States Since 1789, (3) Canada and Latin America, (4) Medieval Europe, (5) Modern Europe, (6) Ancient History, (7) Far East and India, (8) Near East and Africa, (9) European Historiography, (10) American Historiography, (11) Russia, (12) World History.

For independent study in an area in which no appropriate course is offered. To be chosen by a graduate student in history who wishes to take courses normally not open to him on a graduate

basis. Hours to be arranged. Prerequisite: permission of instructor. 3 credits.

### 899. Master's Thesis 6 credits.

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## Home Economics (31)

Marjory Wybourn, *Chairman*

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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 had 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, including one course in each of the following two areas: management and decision-making in the family and family development.

2. A minimum of 9 semester credits selected from the liberal arts or other areas which support the major.

3. Research — a minimum of 4 semester credits, including Home Economics 897, Research Seminar, and Home Economics 898. Research Project, or Home Economics 899. Thesis.

**757, (757). Management and Decision-making in the Family**  
Management related to functions of the family in society. Comparison of families with respect to goals, available resources and managerial behavior. Decision and choice as aspects of individual and group adjustments to changed situations. 3 credits.

**768. Socio-Psychological Aspects of Clothing**

The analysis of research and theory in the social psychological aspects of clothing. An exploration and study of clothing behavior of individuals and groups. 3 credits.

**769. Advanced Textiles**

Investigation and evaluation of fabrics in everyday use. Consumption of textiles with emphasis on economic and social implications. Prerequisite: Home Economics 404 or equivalent. 3 credits.

**771. Experimental Foods**

Application of the experimental method of study to the principles underlying food preparation. Includes laboratory and individuals projects. Prerequisite: Home Economics 418. 3 credits.

**778. Food and Nutrition Trends and Developments**

Investigation and evaluation of current problems in food production, preparation and preservation or of current nutritional developments. Independent study of current literature. 3 credits.

**783. Family Relationships**

A study of husband-wife, parent-child, sibling interactions throughout the family life cycle. 3 credits.

**791. Methods in Home Economics Education**

Home economics education in the school program, curriculum materials, methods, and resources in teaching home economics. 3 credits.

**(792). Methods in Family Relations Education**

The methods and materials used in family relations education in high schools, colleges, churches, and social agencies. Prerequisite: permission of instructor. 2-4 credits.

**795, (795). Projects in Child Development and Family Relationships**

The student, under the guidance of the instructor, will undertake a special project in the area of the family or child development. Conferences, seminars, and discussions of current research in the field. Prerequisite: senior or graduate and permission of instructor. Credit to be arranged. Maximum of 6 credits.

**796, (796). Projects in Home Management**

The student, under the guidance of the instructor, will undertake selected areas of study in the field of home management. Such investigations may include: (a) home management for the disabled, (b) consumer education, (c) management processes, (d) current research. Credit to be arranged. Maximum of 6 credits.

**797. Nutrition Seminar**

Theoretical approach to nutrient metabolism. Critical review of literature in the field of nutrition relative to the principles on which human nutrition is based. Prerequisite: Home Economics 573. 3 credits.

**(798), 798. Seminar in Home Economics Education**

Recent developments and problems in teaching home economics at all levels. Individuals or small groups may work on specific problems in the field. 2 to 4 credits.

**883. The Adolescent in the Family**  
The psycho-social development of the adolescent with attention given to the

heterosexual and familial relationships of the adolescent. 3 credits.

**895, (895). Projects in Food and Nutrition**

The student, under the guidance of the instructor, will select a study, creative project, field experience, or independent work in the area of food and nutrition. 1-3 credits each semester; maximum of 6 credits.

**(896), 896. Projects in Clothing and Textiles**

The student, under the guidance of the instructor, will undertake selected areas of investigation in the field of clothing and textiles. Such investigations may include: (a) philosophy of textiles and clothing in education, (b) current development of textiles, (c) the textile industry, (d) social and psychological interpretation of dress, (e) current research readings in clothing and textiles. 1-3 credits each semester; maximum of 6 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, analysing, and writing a report. 2 credits.

**(898), 898. Research Project**

A study or project which may be selected in lieu of a thesis. To be taken concurrently with Home Economics 897. 2-4 credits.

**899. Thesis**

6 credits.

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## Interdisciplinary Options and Programs

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### Soil and Water Chemistry Option

The chemist can contribute much to the advancement of many scientific disciplines through the application of the principles of chemistry to research problems in these other disciplines. The Departments of Chemistry and Soil and Water Science have instituted an option in the Doctor of Philosophy program in Chemistry which enables the graduate student to apply his chemistry background to research problems of mutual interest to the two departments. A student entering this option must meet the entrance requirements for the Doctor of Philosophy program in Chemistry. So that the student may obtain a background in Soil and Water Science, he will be permitted to substitute graduate level courses in Soil and Water Science for certain courses in Chemistry. His dissertation will be on a basic problem of interest to faculty members in both departments. For further information, write to either the Department of Soil and Water Science or to the Department of Chemistry.

### Chemical Physics Option

Doctor of Philosophy candidates in Chemistry may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Physics. In this option the doctoral student, with the advice of his guidance committee, elects courses in chemistry and physics (or, in some cases, mathematics), writes his dissertation on a research problem (experimental, theoretical, or both) appropriate to interdisciplinary treatment and receives the doctorate in either Chemistry or Physics. In addition, each candidate must satisfy certain other requirements of the department in which the degree is granted. Ordinarily, stu-

dents choosing the Chemical Physics option are expected to have undergraduate degrees in chemistry, physics, or mathematics and reasonably strong backgrounds in the other two disciplines.

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## Language, General (55)

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This course is taught by members of the Departments of French and Italian, German and Russian, and Spanish and Classics. Students wishing to take this course should consult Dr. Charles H. Leighton, Chairman of the Department of Spanish and Classics.

### Languages-Education 791. Problems in the Teaching of Modern Languages in the High School

The special objectives, methods, and devices of modern language teaching in high school. For prospective or actual teachers of French, German, and Spanish. Prerequisite: Intermediate French, German, Spanish; and grade of C or better in Education 758 or one year's teaching experience. 3 credits.

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## Mathematics (84)

M. Evans Munroe, *Chairman*

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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: Mathematics 761-762 or 767-768 or the equivalent of one of these sequences elsewhere. 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

Admission requirements: Same as for Master of Science. Degree requirements: (1) Course work as prescribed by the Department. This will normally include all the courses numbered 833-842 together with several courses numbered 860-898. (2) Proficiency in reading mathematical literature in two of the three languages: French, German, and Russian. (3) Experience in teaching equivalent to at least one-half time for one year. (4) Qualifying examination. This is in two parts. The first part (written) must be taken after three semesters in residence. It will cover basic topics in graduate level mathematics. The second part (oral) is normally taken in the third year and covers more advanced topics. (5) Thesis. This is the principal item in the doctoral program. New and original results will be required. At present, thesis work is available in the fields of algebra, analysis, and topology.

Courses numbered between 600 and 699 may be taken for graduate credit by non-majors only.

### **601-602. Foundations of the Number System**

Postulates and mathematical structures. Various mathematical systems showing the nature and significance of the fundamental principles of arithmetic. Intended primarily for elementary school teachers. Prerequisite: permission of instructor. 3 credits.

### **629. Methods of Applied Mathematics I**

Solutions of ordinary differential equations by D-operators, Laplace Transforms, and by series; representation of functions by definite integrals (Gamma, Beta, and error functions); Bessel functions; Fourier Series. Prerequisite: Mathematics 527. 3 lectures; 4 credits.

### **630. Methods of Applied Mathematics II**

Vector analysis (line, surface, and volume integrals); elementary variational techniques; development of some partial differential equations by Laplace Transforms and by Green's functions. Prerequisite: Mathematics 629. 3 lectures; 4 credits.

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

### **741. Mathematical Statistics I**

Sampling theory; estimation of parameters; the multivariate normal distribution. Prerequisite: Mathematics 542. 3 credits.

### **742. Mathematical Statistics II**

Testing statistical hypotheses; confidence intervals; regression and correlation; nonparametric methods, and other topics. Prerequisite: Mathematics 741. 3 credits.

### **753-754. Numerical Methods and Computers**

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: Mathematics 401 and 527. 3 recitations, 1 laboratory, 4 credits.

### **755. Fundamental Concepts of Geometry**

Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; introduction to non-Euclidean geometry, topology, and the elementary differential geometry of curves and surfaces. Prerequisite: Mathematics 426. 3 credits.

### **756. Topics in Number Theory**

Elementary properties of integers; the Euclidean algorithm; divisibility; diophantine equations of the second degree; selected topics in diophantine approximation and number-theoretic functions. Prerequisite: Mathematics 531. 3 credits.

### **761. Higher Algebra I**

The integers; the rational and complex number systems; congruences; polynomials; groups; rings; integral domains; fields. Prerequisite: Mathematics 531. 3 credits.

### **762. Higher Algebra II**

Vector spaces and transformations; matrices and determinants. Prerequisite: Mathematics 531. 3 credits.

### **767. Real Analysis I**

The real number system; elements of set theory; theory of limits; continuous functions and their properties; differentiability and the mean value theorem. Prerequisite: Mathematics 531. 3 credits.

**768. Real Analysis II**

The Riemann integral; uniform convergences; double and iterated limits; applications of double limit theorem to series, limits under the integral sign and existence theorems for differential equations. Prerequisite: Mathematics 531. 3 credits.

**771. Group Theory and Principal Ideal Domains**

Finite groups and their applications; Galois theory; Sylow theorems; structure of principal ideal domains with applications to elementary divisor theory; unique factorization domains. Prerequisite: Mathematics 761. 3 credits.

**781. Theory of Approximation**

The theorems of Weierstrass on approximation of continuous functions; the Tschebycheff approximation problem; Tschebycheff polynomials; trigonometric polynomials of best approximation; interpolation; the formulas of Lagrange and Newton; trigonometric interpolation. Prerequisite: Mathematics 426. 3 credits.

**782. Nonlinear Differential Equations**

Phase plane analysis of lineal systems and nonlinear conservative systems; stability theorems; limit cycles and periodic solutions; the Van der Pol equation; the method of Kryloff and Bogoliouhoff. Prerequisite: Mathematics 527. 3 credits.

**783. Introduction to Differential Geometry**

A first course in the metric differential geometry of curves and surfaces in Euclidean space. Prerequisite: Mathematics 527. 3 credits.

**784. Introduction to Topology**

Elementary point-set topology in metric and topological spaces, in particular the real line and plane. Prerequisite: Mathematics 531. 3 credits.

**786. Introduction to Theory of Differential Equations**

Existence and uniqueness theorems for ordinary differential equations; theory of linear ordinary differential equations of order  $n$ ; oscillation and comparison theorems for second order linear ordinary differential equations; partial differential equations of the second order. Prerequisite: Mathematics 531. 3 credits.

**788. Complex Analysis**

The complex number system; analyticity; elementary functions; Cauchy integral theorem and formulas; Taylor and Laurent series; singularities and residues; conformal mapping. Prerequisite: Mathematics 531. 3 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; geometries, 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 geometrics; 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.

**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 1950's 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 the following: linear algebra, vector spaces, groups, rings and ideals, 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 supple-

ment 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.

**831. Set Theory**

Foundations of the theory of sets; ordinal and cardinal numbers; Zorn's lemma; applications. 3 credits.

**833-834. Algebra**

Groups; rings; modules, fields; linear algebra. 3 credits.

**835-836. Real Analysis**

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

**851-852. Differential Equations**

Ordinary differential equations; existence theory; linear equations; Sturm-Liouville theory; nonlinear autonomous systems; Poincare-Bendixson theory; partial differential equations; second order

linear equations; initial value problems; hyperbolic equations; the Dirichlet problem. 3 credits.

**855-856. Applied Mathematics**

Calculus of variations, integral equations; operator theory; distributions; Hilbert spaces. 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 Topological and Algebraic 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; non-linear 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.

**898. Reading Courses**

Offered in the following areas: (a) Algebra, (b) Analysis, (c) Topology, (d) Geometry, (e) Topological and Algebraic Analysis, (f) Differential Equations, (g) Applied Mathematics, (h) Probability and Statistics. 3-6 credits.

**999. Doctor of Philosophy Thesis**

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## Mechanical Engineering (85)

Robert W. Corell, *Chairman*  
Douglas M. Norris, Jr., *Director of Graduate Studies*

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The Mechanical Engineering Department offers programs of study, both from the viewpoint of the engineering sciences and engineering design, in mechanics, materials, 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 for a Bachelor of Science degree in his field at the University of New Hampshire.

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 897, 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 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 is required for enrollment in all Mechanical Engineering graduate courses.

**643. Machine Design and Analysis**  
Analysis and design of mechanical elements and systems, utilization and further development of the fundamentals of the mechanics of solids and dynamics. 3 credits.

**653. Heat Transfer**  
Analysis of heat transfer phenomena; steady-state and transient conduction, radiation, and convection; engineering applications. 3 credits.

**657-658. Heat and Power Systems**  
The application of thermodynamics, fluid mechanics, combustion, heat transfer and other engineering sciences

to the design and evaluation of heat and power systems. 2 lectures; 1 laboratory; 3 credits.

**671. Naval Architecture I**  
Introduction to naval architecture; geometry and hull form delineation; hydrostatic characteristics of floating and submerged bodies; introduction to ship strength; computer applications to problems. 3 credits.

**701. Macroscopic Thermodynamics**  
A continuation of the study of thermodynamic principles using an analytical approach consistent with that of Gibbs and Caratheodory. 3 credits.

**702. Statistical Thermodynamics**  
An introduction to statistical thermodynamics. 3 credits.

**726. Experimental Mechanics**  
Experimental methods and their underlying theoretical bases are developed and applied to the measurement of stress, strain, and motion. 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.

**728. Advanced Dynamics**  
The foundations of dynamics leading to Lagrange's equations and Hamilton's principle; gyroscopic effects in mechanical systems; vibrations. 4 credits.

**729. Kinematics**  
The vector equations of relative motion are used to analyze mechanisms of varying complexity; graphical and analytical methods are used to analyze space linkages. 2 lectures; 1 laboratory; 3 credits.

**736. 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. 3 credits.

**740. 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. 3 credits.

**744. Introduction to Vibrations**  
Review of linear system concepts; shock spectra; many degrees of freedom; uncoupling of conservative systems; energy and Lagrange's equations; introduction to continuous systems, numerical methods. Extensive use is made of the analog and digital computer. 4 credits.

**746. Control of Physical Systems**  
Theory and methods for modeling and evaluating electromechanical, hydraulic, and pneumatic control systems. 3 credits.

**751. 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. 3 credits.

**755. 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. 2 lectures; 1 laboratory; 3 credits.

**756. Propulsion Systems**  
Application of basic and engineering sciences to the engineering problems of propulsion systems. 3 credits

**764. X-ray Metallography**

Theoretical and experimental studies of x-ray diffraction. 3 credits.

**772. Naval Architecture II**

Hydrodynamic resistances of surface ships and submerged bodies; model testing theory; powering and propellers; use of Standard Series tests; introduction to ship motion, control steering, and rudders; concepts of ship design; computer application to problems. 3 credits.

**791. Special Topics in Mechanics**

Content of course may vary from year to year. 4 credits.

**801. Continuum Mechanics**

Analysis of three-dimensional stress, strain, and velocity strain by tensor methods; equilibrium, compatibility, continuity and constitutive equations of solids and fluids. Simple examples from both fields are considered. 4 credits.

**802. Irreversible Thermodynamics**

Non-equilibrium thermodynamics from the viewpoint of fluctuation theory. The Onsager reciprocal relations. Prerequisite: Mechanical Engineering 701. 3 credits.

**803. Conduction Heat Transfer**

Heat conduction equation; temperature fields and the heat flux vector; analytical solution of the conduction equation in several variables; initial and boundary value problems; numerical methods of solution. 3 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. 3 credits.

**805. 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. 3 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. Schwartz-Christoffel theorem and vortex motion. 3 credits.

**810. Compressible Fluid Flow**

General equations of motion for real and ideal compressible fluid flow including boundary layer equations; methods of solution. Prerequisite: Mechanical Engineering 751 or 736, Mathematics 630. 3 credits.

**812. 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.

**820. 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. 3 credits.

**822. 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. 3 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, inhomogeneous, 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.

### **891. Topics in Mechanics**

Content of course may vary from year to year. 4 credits.

### **892. Topics in Thermodynamics**

Content of course may vary from year to year. 3 credits.

### **893. Topics in Materials**

Content of course may vary from year to year. 3 credits.

### **894. Topics in Engineering Design**

Content of course may vary from year to year. 3 credits.

### **895-896. Graduate Independent Study**

Investigation of graduate level problems or areas germane to mechanical engineering. 1-4 credits.

### **897. Master's Project**

The student will work with a faculty member on a well defined research and/or design problem. A written report and seminar will be presented. 4 credits.

### **899. Master's Thesis**

6-10 credits.

For additional courses, see listing under Technology, page 117.

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## **Microbiology (47)**

Lawrence W. Slanetz, *Chairman*

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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 and pass an examination covering his graduate courses and thesis.

Candidates for the Doctor of Philosophy degree must demonstrate proficiency in reading microbiological literature in two foreign languages, usually French and German, must demonstrate to the doctoral committee a broad basic knowledge of the field of Microbiology, and must complete a dissertation on some original research in 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. Prerequisite: Microbiology 503. 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. Metcalf. Prerequisite: Microbiology 503. 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. 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. Metcalf. 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 plant or animal infections caused by viruses. Mr. Metcalf. Prerequisite: Microbiology 702. 1 lecture; 3 laboratories; 4 credits.

### **(708). Marine Microbiology**

Characterization of microbes in the sea as to taxonomy, physiology, ecology, and transformations of carbon, nitrogen, sulfur, and phosphorus; methods of sampling and enumeration; biogeochemistry; properties of sea water and the marine environment. Parallels to soil microbiology will be drawn. Mr. Jones. Prerequisite: Microbiology 503 and Biochemistry 751. 2 lectures; 1 laboratory; 4 credits.

### **795, 796. Problems in Microbiology**

Special problems, depending upon the training and desire of the student. Elective only upon consultation. Staff. Credits to be arranged.

### **800. Systematic Bacteriology**

Procedures and methods for the classification of bacteria; review of modern systems of classification. Mr. Chesbro. 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. 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; 2 laboratories; 4 credits.

### **804. Microbial Genetics**

An introduction to genetic principles and methodology applicable to microorganisms; fine structure of genetic material, mutation, selection, adaptation, recombination, transformation, and transduction. Mr. Hickson. Prerequisite: permission of instructor. 2 lectures; 2 laboratories; 4 credits.

### **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

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## Music

Keith Polk, *Chairman*

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The Department of Music offers programs leading to the degrees of Master of Arts in Music and Master of Science in Music Education.

### Master of Arts in Music

Admission to this program is dependent upon a Bachelor of Arts degree in Music or its equivalent from an accredited institution. Placement examinations in music theory, music history, and in piano are administered by the Department of Music. Students not meeting standards in these phases of achievement will be required to take undergraduate courses to meet their deficiencies. A reading test in German is also required.

Concentration in studies for degree is in the field of music history and music theory. The degree is not organized as a terminal degree in itself, but does prepare a student for work at the doctorate level. The content of the degree emphasizes the disciplines of bibliography, research, the writing of papers, analytical studies of music literature, readings in source material, and advanced theory. The following courses are required: Music 855, 856, 857, 858, 891, 892, 893. The remainder of the courses may be drawn from the 700 series in Music or the 600, 700, and 800 series in other departments with the permission of the adviser. Sufficient electives are required to total 30 credits.

### Master of Science in Music Education

Admission to this program is dependent upon an appropriate Bachelor's Degree in Music Education or its equivalent

in an accredited college. A placement examination is administered by the Department of Music. Deficiencies must be made up.

The goal of this degree is to develop a stratum 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 of study in music education; a satisfactory recital appearance; a major composition, orchestration, or band arrangement; the preparation and conducting of a major work in public performance for band, orchestra, or choir. The following courses must be taken: Music 855, 893, Music Education 796, 883 or 884. Also required are 6 credits from the following courses in education: Education 841, 858, 865, 871, 883, 885, 886, and the 700 courses taught by the Educational Department of Education. 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 are required to total 30 credits.

### Music (63)

**701. Masters of the Renaissance**  
Important composers of the fifteenth and sixteenth centuries and their works: Vittoria, Palestrina, Byrd, and others. 2 credits.

### 703. Romantic Music of the Nineteenth Century

The sonata form as a basis for 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. 2 credits.

**704. Twentieth Century Music**  
Music of the twentieth century, including its literature, its trends, and an analysis of techniques, styles, forms, and expression. 2 credits.

**705. The Life and Works of Beethoven**  
The piano sonatas, symphonic works, and the string quartets. Lectures, analysis, reports, required readings, and listening. 2 credits.

**707-708. Survey of Opera and Oratorio**  
A historical and musical survey of the opera and oratorio from their common birth, through the development of each specific form to the present day. Particular stress is given to political and religious influences. 2 credits.

**709-710. Survey of Pianoforte Literature**  
The history and development of keyboard literature from Bach to the present. A discussion and performance of the works of Bach, the sonatas and concertos of Haydn, Mozart, Beethoven, Schubert, the Romantic composers, and of contemporary writers. 2 credits.

**719-720. Counterpoint**  
First semester: Sixteenth century polyphony based on the style of Palestrina. Second semester: free instrumental counterpoint based on the styles of Bach and Handel. Twentieth century counterpoint will be discussed in the closing classes of the course. Prerequisite: Music 523-524 or permission of instructor. 2 credits.

**721-722. Canon and Fugue**  
Free counterpoint in three and four parts, double counterpoint, the writing of simple two-part inventions, choral preludes, etc. The canonic and fugal studies will be based largely upon the works of Bach and will have as their objective the composition of a two-, a three-, and a four-voiced fugue.

Prerequisite: Music 719-720 or permission of instructor. 2 credits.

**723-724. Composition**  
The various smaller harmonic forms, the variation, the rondo, and the sonata forms will serve as models for composition. Prerequisite: Permission of instructor. 2 credits.

**725-726. Orchestration and Chorestration**  
Instruments and methods of combining them into coherent arrangements arriving at successful balances for the band and orchestral arranger. The characteristics, range and tone quality of the instruments are fully covered and transcriptions are made. Orchestral effects are studied. Chorestration is offered during the latter part of the second semester. The techniques of writing for solo voices, for mixed voices, men's and women's voices, are taken up through the medium of arrangements, and original work. Prerequisite: permission of instructor. 2 credits.

**731. Music in the Medieval Period**  
Periods considered include plainsong, music of the Mass, secular monophony, beginnings of polyphony. French, and Italian Ars Nova. 2 credits.

**733. Music of the Baroque**  
Early, middle, and late baroque music and its various schools. The cantatas, lute and keyboard music, the early concerto, and sonata are studied in detail. The literature of Bach and Handel is investigated. 2 credits.

**734. Music in the Classical Period**  
The music of the rococo and classical periods. The following subjects will be investigated: "style galant," opera seria and opera buffa, the keyboard sonata, and the music of Haydn and Mozart. 2 credits.

**817, (817). Applied Music for Graduate Credit**

(1) Piano; (2) Organ; (3) Violin, Viola; (4) Violoncello; (5) Voice; (6) Woodwind; (7) Brass; (8) Percussion. Further development of technique, music interpretation and repertory. Emphasis may also be directed toward the functional use of the instrument in the schoolroom. Prerequisite: must exhibit sufficient proficiency to warrant graduate study and permission of Department Chairman and the student's graduate supervisor. Audition required. A student may register for credit in the same courses in successive years with the approval of his major professor. Music staff. 1-2 credits.

**855. Introduction to Bibliography**  
The student will become familiar with the reference materials of music, dictionaries, journals and periodicals, and with major monographs and editions. 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. 3 credits.

**857. Readings in Music History: 1600-1820**  
An opportunity to read and study in detail a restricted number of monographs and editions. 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. 3 credits.

**891, 892. Research Seminar**  
Guidance in individual research projects. Permission of instructor. 3 credits.

**893. Theory Seminar**  
Through reading, analysis, and composition, the student is acquainted with music theory from the Middle Ages to

Monteverdi. 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. 3 credits.

**Music Education (64)**

**751, 752. Techniques and Methods in Choral Music**  
A lecture workshop course touching upon some of the problems and solutions in the organization and performance of high school and college glee clubs and community choirs. Emphasis is placed on techniques of choral conducting and rehearsal, repertory, and materials. Offered to Music Education students who wish to place a greater emphasis on a vocal option in the curriculum rather than instrumental. A student taking 751, 752 may substitute them for two of the instrumental techniques and methods courses. 3 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 and the classification of voices; the selection of vocal and instrumental materials to fit the needs of the individual group, in order to insure the maximum growth and musical development of the students; and the building of unified concert programs. Problems of administration and management, and the relationship of the teacher to school and community. Observation of music programs in secondary schools. Prerequisite: Education 758. 3 lectures; 1 laboratory; 3 credits.

**792. Problems in the Teaching of Elementary School Music**  
Aims, scope, and organization of materials and activities in the elementary



schools in keeping with modern trends in educational philosophy. The child voice, its care, and development. A demonstration of materials and methods for the various grades. Observations of elementary school music. Prerequisite: Education 758. 3 lectures; 1 laboratory; 3 credits.

#### **796. Organization and Administration of School Music Groups**

Problems of organizing and administering school orchestras, bands, glee clubs, choruses and small ensembles, such as objectives, motivation, schedule, discipline, equipment, programs, finances, rehearsal techniques, contests and festivals, materials, personnel selection, and grades. 3 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 used as required. Detailed attention given to interpretation. Project required. 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 opportunities to act as assistant conductors for some of the choral organizations on campus. Evaluation of current high school and college choral repertoires. 3 credits.

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## **Physics (86)**

Robert E. Houston, Jr., *Chairman*

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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. To assist in starting a student's work at the proper level, a placement examination is required of all entering graduate students. This examination will be offered prior to the fall registration period.

### **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 21) 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. 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 as well as the advanced test in physics). The results of this examination will be used in conjunction with transcripts to evaluate the applicant's undergraduate training. The courses required for a Master of Science degree include Physics 833, 839, 841, and 843.

Candidates may select one of the following two options:

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. Candidates for the degree must pass the placement examination with distinction within one year of enrollment. Admission to candidacy for the degree is achieved by demonstrated ability in formal course work, satisfaction of the language requirement, and by passing a written and oral qualifying examination based on courses in the graduate physics curriculum. For students entering with a Master's degree, the qualifying examination must be taken within one year of enrollment; for students entering with a Bachelor's degree, the qualifying examination must be taken within two years of enrollment. Students are allowed two attempts to pass the qualifying examination. Finally, upon completion of a thesis, the doctoral candidates will take an oral examination based on his area of research.

The courses required for a Doctor of Philosophy degree consist of 831, 833, 839, 841-842, 843-844, and five courses selected as follows:

a) Two courses from any *one* of the following areas

- Area 1 835-836 Statistical Mechanics
- Area 2 861-862 Quantum Mechanics
- Area 3 863-864 Nuclear Physics
- Area 4 865-866 Solid State Physics

Area 5 850,852 Plasma Physics

b) Three additional courses chosen from the above list of areas. The language requirement consists in demonstrating a reading ability in one foreign language chosen from either 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.

### Chemical Physics Option

Doctor of Philosophy candidates in physics may elect to enter the Chemical Physics program, an interdisciplinary program offered jointly with the Department of Chemistry. In this option the doctoral student, with the advice of his guidance committee, elects courses in physics and chemistry (or, in some cases, mathematics), writes his dissertation on a research problem (experimental, theoretical, or both) appropriate to interdisciplinary treatment, and receives the doctorate in either physics or chemistry. In addition, each candidate must satisfy certain other requirements of the department in which the degree is granted. Ordinarily, students choosing the chemical physics option are expected to have undergraduate degrees in physics, chemistry, or mathematics and reasonably strong backgrounds in the other two disciplines.

### 607. Physical Optics

Maxwell's equations, the nature of light, interference, diffraction, polarization, and related phenomena. (Offered on request.) Prerequisite: Mathematics 527. 3 credits.

**701. Introductory Quantum Mechanics**

Quantum mechanics with application to atomic physics. Prerequisite: Physics 503 and 704. 3 credits.

**702. Atomic and Nuclear Physics**

Magnetic moments, spin, identical particles, multielectron atoms, collision theory, and the nucleus. Prerequisite: Physics 701. 3 credits.

**703-704. Electricity and Magnetism**

Foundation of electromagnetic theory, including electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents. Maxwell's field theory, and an introduction to electrodynamics. 3 credits.

**831-832. Mathematical Physics**

Differential equations of physics, complex variables, orthogonal functions, variational methods, matrices, vector, and tensor analysis. 3 credits.

**833-834. Experimental Physics**

Modern research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear, atomic, and molecular phenomenon. 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.

**837. Mathematical Physics**

Formulation and solution of physical problems grouped according to their mathematical properties. (Offered on request.) Prerequisite: Physics 831-832. 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: Physics 701, 839. 3 credits.

**850. Plasma Physics I**

**(Hydromagnetic Phenomena)**

Steady state conditions, hydromagnetic waves, turbulence, shock waves, and individual particle motion will be discussed. 3 credits.

**852. Plasma Physics II**

A description of Plasma Physics from the Kinetic Theory point of view. (Offered on request.) Prerequisite: Physics 835. 3 credits.

**861-862. Advanced Quantum Mechanics**

Generalized formulation of quantum mechanics, formal scattering theory and introduction to relativistic theory. Field theory and related topics. Prerequisite: Physics 839 and 844. 3 credits.

**863-864. Nuclear Physics**

Formulation of theory underlying current experiments. Prerequisite: Physics 843. 3 credits.

**865-866. Solid State Physics**

Development of quantum mechanical theory of solids, transport, phenomena, etc. (Offered on request.) Prerequisite: Physics 843 and 835. 3 credits.

**887. Introduction to Space Science**  
Detailed study of the earth and its physical environment, interplanetary medium, magnetosphere, the solar system and beyond. Prerequisite: permission of instructor. 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.

**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**

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## **Plant Science (32)**

Lincoln C. Peirce, *Chairman*

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The graduate research program in Plant Science is concerned with solving basic and applied problems associated with production of horticultural or agronomic crops. Facilities include laboratories, field and greenhouse research areas, and plant growth chambers.

Program emphasis is directed toward breeding and genetics and toward crop

physiology or biochemistry. Research and teaching in plant genetics, cytogenetics, and plant breeding is a major strength and is complemented by expanding University programs in statistics and in biochemical and microbial genetics. (See descriptions of Genetics Program.) Increased emphasis also is being given to research in plant metabolism, mineral nutrition, and growth and development. In certain instances, these research areas are integrated with the genetics projects to provide unique approaches toward solving agricultural problems.

It is recommended that all graduate students first complete work for the Master of Science degree. Candidates for this degree will be required to pass an oral examination and will usually be required to prepare a thesis. Candidates for the Doctor of Philosophy degree, in addition to the general requirements, must also demonstrate proficiency in a language approved by the major department. This requirement may be satisfied during graduate study or upon entering graduate school either by presenting 8 college semester credits with each course grade no less than B, or by passing a language examination approved by the Department. In general, German, French, Spanish, and Russian are considered acceptable for American students. Foreign students whose native language is not English will satisfy the language requirement by passing a qualifying English examination administered by the Department. A thesis on original research in the student's area of specialization is required for the doctoral degree.

### **704. Annual Crops**

Annual grains, silage crops, and potatoes and their characteristics of growth as affected by culture and management. Mr. Higgins, 2 lectures; 1 laboratory; 3 credits. (Alternate years; not offered in 1968-1969.)

### **706. Pasture-Hay Crops**

The important forage and pasture crops, their characteristics of growth, culture, and management. Mr. Higgins. Prerequisite: Botany 41I, Plant Science 402. 3 lectures; 1 laboratory; 4 credits. (Alternate years; offered in 1968-1969.)

**708. Nutrition and Water Relations**  
Mineral requirements of plants and response to deficiencies. Effect of soil and atmospheric environments on plant growth and differentiation of plant parts. Mr. Eggert. Prerequisite: 3 credits in plant physiology. 2 lectures; 1 laboratory; 3 credits.

### **753. Fruit Crops**

The growth and management of tree and small fruit crops. Pest control, storage, marketing, and response to pruning and grafting. Mr. Eggert. Prerequisite: 7 credits in botany, Plant Science 406; 7 credits in soils. 3 lectures; 1 laboratory; 4 credits (Alternate years; offered in 1968-1969.)

### **764. Vegetable Crops**

Systematic classification of vegetable crops, their use, management, and response to environment and competition in food and seed production. Mr. Peirce. Prerequisite: Botany 41I, Plant Science 406 or equivalent. 3 lectures; field trips; 3 credits. (Alternate years; offered in 1968-1969.)

### **765. Systematic Pomology**

Taxonomic relationships and group characteristics among varieties of tree and small fruits. Mr. Eggert. Prerequisite: 6-8 credits in botany. 1 lecture; 1 laboratory; 2 credits. (Alternate years; not offered in 1968-1969.)

**768. Plant Growth and Development**  
Biochemical and physiological aspects of crop production. Bases for changes in growth or development of plants effected by environment or treatments. Mr. Eggert. Prerequisite: Chemistry 545, Botany 756 or equivalent. 3 credits.

(Alternate years; not offered in 1968-1969.)

### **774. Methods and Theory of Plant Breeding**

History, theory, and use of plant breeding systems, including bulk and pedigree methods, recurrent selection, gamete selection, and testing. Mr. Peirce. Prerequisite: 3 credits in genetics. 3 credits. (Alternate years; not offered in 1968-1969.)

### **795-796. Investigations in Plant Science**

#### **Plant Growth and Development**

Mr. Eggert, Mr. Routley.

#### **Breeding and Genetics**

Mr. Dunn, Mr. Peirce, Mr. Rogers, Mr. Loy.

#### **Crop Production and Management**

Mr. Higgins, Mr. Eggert, Mr. Peirce.

#### **Ornamentals and Turfgrass**

Mr. Higgins, Mr. Rogers

Selected topics for crop or library research. Prerequisite: permission of instructor. 1-4 credits.

### **832. Developmental Genetics**

Relation of protein, RNA, and DNA synthesis to development, chromosome differentiation, nuclear-cytoplasmic interactions, genic and non-genic control of subcellular organization, cellular continuity, cell associations, experimental embryology, hormones and post-embryonic development, gene regulations in development, and neoplastic growth. Mr. Loy. Prerequisite: permission of instructor. 3 credits. (Alternate years; offered in 1968-1969.)

### **851. Plant Genetics**

Linkage, euploidy, aneuploidy, cytoplasmic inheritance, mutation and genetics of disease resistance. Mr. Dunn. Prerequisite: 3 credits in genetics. 3 credits. (Alternate years; not offered in 1968-1969.)

### 853. Cytogenetics

Chromosome aberrations and their behavior. Effect of radiation on chromosomes. Mapping and laboratory technique in cytogenetic analysis. Mr. Rogers. Prerequisite: 3 credits each of genetics and cytology, 2 lectures; 1 laboratory; 3 credits. (Alternate years; offered in 1968-1969.)

### 895-896. Research in Plant Science Growth and Development

Mr. Eggert, Mr. Routley.

### Breeding and Genetics

Mr. Dunn, Mr. Peirce, Mr. Rogers,  
Mr. Loy.

### Crop Production and Management

Mr. Higgins, Mr. Eggert, Mr. Peirce.

### Ornamentals and Turfgrass

Mr. Higgins, Mr. Rogers.

Selected topics involving library study and greenhouse, growth chamber, or field research. 1-4 credits.

### 897-898. Graduate Seminar

Library research in current topics of plant science. Practice in presentation of reports. Required of all graduate students majoring in plant science and open to related departments. Staff. 1 credit.

### 899. Master of Science Thesis

A thesis study of some phase of plant science is usually required of candidates for an advanced degree. 6-10 credits.

### 999. Doctor of Philosophy Thesis

Candidates must complete a thesis on original research in plant science.

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## Political Science (52)

Robert B. Dishman, *Chairman*

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Normally a candidate for admission to graduate study in Political Science or Public Administration is expected to have completed at least 18 semester credits of political science as an undergraduate with a grade of C or better. In exceptional cases, however, the

Department reserves the right to waive this requirement if the candidate is prepared to enroll without credit in those basic undergraduate courses in which he is deficient.

The Department of Political Science offers two advanced degrees: a Master of Arts in Political Science and a Master of Public Administration.

To receive a Master of Arts in Political Science a candidate must complete 30 credits: 18 credits in political science numbered 800-899, including six credits for the thesis, and 12 credits in related fields. He must also pass a written examination in three basic fields within the discipline and an oral examination on his thesis. It is expected that all Master of Arts candidates, except those whose major field of interest is American government, will be able to read some foreign language. The basic fields in which candidates may be examined are the American political system, comparative politics, international relations, and political thought.

To receive a Master of Public Administration degree, a candidate must complete 30 credits: 9 credits dealing with the administrative process; 12 credits in statistics, public finance, personnel administration, and research in government problems; and the balance selected to suit his particular interests. The degree is designed for individuals intending to pursue an administrative career. Those without previous experience in some government agency are expected to serve a three- to six-month internship for which they receive academic credit. Candidates for an advanced degree in political science or public administration may take any of the courses listed below, but they must do so at the graduate, i.e., 800-899, level. They will be expected to attend the lectures, follow a prescribed reading program, take the required examinations, and write an extended paper in lieu of the final examination. Unclassified students and candidates for an advanced degree in some other discipline will be permitted

to take the courses at the 700 level if the instructor consents.

**715, (815). Comparative Politics**  
The political dynamics and institutions in developed and under-developed areas are analysed by comparative method. Mr. Wurzburg. 3 credits.

**717, (817). Continental European Political Parties**  
Theories of representation and political parties are related to historical circumstance. Changes within and among political parties are connected with the changing role parties play in the political process. Mr. Wurzburg. Prerequisite: permission of instructor. 3 credits.

**726, (826). Pressure Groups and the Government Process**  
Political interest groups are analysed as an integral, if unofficial, part of the American political system in their efforts to influence public officials by lobbying, propaganda, and direct political action. Mr. Ford. Prerequisite: Political Science 406. 3 credits.

**727, (827). The American Political Executive**  
The behavior of the American President and other political executives in the formulation and execution of policy. The role of public opinion, groups, and voting behavior in executive political leadership and power and the political executive in democratic political systems in modern times and prospects for the future. Mr. Craig. 3 credits.

**728, (828). Legislative Behavior and the United States Congress**  
The role of Congress and legislative behavior in the American political system including the organization, operation and process of legislating, and the personnel and informal rules of the legislative process. The influence of groups, public opinion, elections and decision-making agencies on the legis-

lative policy-making process and the analysis of proposed reforms of legislatures, including the functions of legislative policy-making in democratic political systems. Mr. Craig. 3 credits.

**731, (831). The Administrative Process**  
The principal concepts of governmental administration, including theories of organization, administrative leadership, internal management, and administrative responsibility and control. The relationship of group behavior and policy development to the administrative process. Prerequisite: Political Science 406 or Sociology 400. 3 credits.

**732, (832). Comparative Administration**  
An examination of the structure, conceptual foundations, and dynamics of administrative systems in major countries. Mr. Savage. 3 credits.

**736, (836). Urban Government and Politics**  
An analysis of the role of government in planning and managing the problems of the urban community. Metropolitan planning will be treated in relation to zoning, land use, open space preservation, and transportation. The administrative functions to be studied include welfare, health, urban renewal and police protection. Mr. O'Connell. 3 credits.

**741, (841). Administration of Justice**  
A comparative study from primitive times to the present of the administration of criminal and civil justice under various legal systems. The modern role of the police, public prosecutor, judge, jury, counsel, and interest groups in the judicial process in the United States and in other nations, including England and Wales, France, Germany, and the Soviet Union. Mr. Dishman. 3 credits.

**742, (842). The Supreme Court and the American Constitution**

The Supreme Court considered as both a court of law and a political institution. The origins and development of judicial review and changing conceptions of the judicial process. The Supreme Court as supreme arbitrator in disputes between the nation and the states, the President and Congress, and majority rule and minority rights. Mr. Dishman. Prerequisite: Political Science 406 or permission of instructor. 3 credits.

**745, (845). World Politics**

The basic driving forces in international relations, including the nature of political power and its extension or limitations. Geopolitics, nationalism, ideology, imperialism, international economic relations, balance of power, warfare, regulation of arms, international law, and collective security. Mr. Holden. 3 credits.

**746, (846). Foreign Policies of the Great Powers**

Fundamental factors influencing contemporary foreign policy formulation in the United States, the Soviet Union, the British Commonwealth, and other significant powers. Problems and choices confronting policy makers of these powers in dealing with issues involving the United Nations, regional organizations, Western Europe, Middle East, and Asia. Mr. Holden 3 credits

**747, (847). Conduct of Foreign Policy**

The constitutional, institutional, and procedural aspects of decision-making within the framework of U. S. national security and national policy. Some emphasis will be given to the ideological framework within which the decision-making process occurs. Mr. Larson. 3 credits.

**751, (851). Contemporary Southeast Asia**

A comparative study of the political and social development of Southeast Asia. The significance of the role of independence and dependence; the competing influence of communism and Western democracy; the special significance of the role of China, India, Great Britain, and the United States. The states to be studied include the Philippines, Laos, Cambodia, Viet Nam, Thailand, Burma, Malaysia, and Indonesia. Mr. Holden. 3 credits.

**752, (852). Governments of Emerging Countries**

A comparative study of recent developments in the politics and governing systems of Asia and Africa, and regional arrangements indigenous to these areas. Prerequisite: Political Science 405 or permission of instructor. Mr. Savage. 3 credits.

**754, (854). Governments of Latin America**

A comparative study of the politics and government systems of Latin America with some consideration given to regional arrangements. Prerequisite: Political Science 405 or permission of instructor. Mr. Larson. 3 credits.

**756, (856). Contemporary South Asia**

A comparative and analytical study of the historic, political, social, and economic influences in modern South Asia. Special attention will be paid to the rivalries between Pakistan and India, to the pressures of the Soviet, the United States and China; to the influences of both the Commonwealth and the Afro-Asian bloc ideals and goals. The states to be included are Pakistan, India, Ceylon, Nepal, and Afghanistan. Mr. Holden. 3 credits.



**757, (857). Government and Politics of China**

An analysis of the political, economic, and cultural institutions of contemporary China and of the circumstances and ideologies which contributed to their development. Attention is given to China's place in world politics and its relations with the Soviet Union and other Communist states. Mr. Woodruff. 3 credits.

**758, (858). Government and Politics of Japan**

An analysis of the political, economic, and cultural institutions of contemporary Japan and of the circumstances which helped to shape them. Attention is also given to Japan's place in world politics and its relations with the Soviet Union, China, and the United States. Mr. Woodruff. 3 credits.

**763, (863). Political Theory I**

A critical, analytical and contextual survey of Greek, Roman, medieval and Renaissance political theory. In depth treatment of major philosophers — Plato, Aristotle, St. Augustine, St. Thomas Aquinas, Machiavelli — will be undertaken, as time permits. Mr. Jaffe and Mr. Romoser. 3 credits.

**764, (864). Political Theory II**

A critical, analytical, and contextual survey of representative modern political theorists. In depth treatment of philosophers whose contributions to political thought have been primary — Hobbes, Locke, Rousseau, Hegel, Marx — will be undertaken as time permits. Mr. Jaffe and Mr. Romoser. 3 credits.

**765, (865). Contemporary Political Theory**

A survey and analysis of contemporary political theories. The crisis in democratic thought, totalitarian ideology, the search for scientific political theory. Prerequisite: Political Science 763, 764 or permission of instructor. Mr. Jaffe and Mr. Romoser. 3 credits.

**771, (871). Research in Political Behavior**

An introduction to the methodology and techniques of research in political behavior, broadly defined. Emphasis will change from time to time to include various types of empirical research and their optimal use. Such approaches as surveys, experimental designs, and basic data processing techniques will be combined with library and documentary research to produce a significant research paper by each student. Mr. Craig. 3 credits.

**775, (875). International Law**

The theory and practice of international law and its relation to the international community of nation-states and international organizations. Also, the function of law in international relations as analyzed from decisions of national and international tribunals and as manifested in constitutions, charters and other international documents. Permission of instructor. Mr. Larson and Mr. Woodruff. 3 credits.

**776, (876). International Organization**

The theory of collective security and cooperation and the practice of international organizations as a response to meeting the needs of the international community. Emphasis will be placed upon the League-United Nations System and specialized regional organizations. Prerequisite: Political Science 765 or permission of instructor. Mr. Larson and Mr. Romoser. 3 credits.

**779, (879). Public Policy and Regionalism**

The regional decision-making process in the United States with shifting public policy emphases. Mr. O'Connell. 3 credits.

**795, 796, (895, 896). Selected Topics in Political Science**

This course number will be used for special courses that are not regularly offered. Members of the staff. 1-6 credits.

**797, 798, (897, 898). Seminar in Government**

A selected current topic from government, political philosophy and history, political behavior, public law, public administration, or international relations. Each student is held responsible for a specific phase of the selected problem. He will also, through the techniques of the seminar, acquaint himself with the whole project. Restricted to undergraduates with honor grades and graduate students in social science. Advance copies of the syllabus may be secured from the Department Chairman. Permission of instructor. Members of the staff. 3 credits.

**899. Master's Thesis**  
6-9 credits.

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## **Psychology (67)**

Raymond L. Erickson, *Chairman*

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### **Doctor of Philosophy**

The Department of Psychology offers a program of study leading to the Doctor of Philosophy degree. The doctoral program is specifically designed to prepare psychologists who plan to become college or university teachers.

Its major goal is the development of competent general psychologists who have attained depth in a special area and who are capable of extending knowledge through research. In addition, however, a concern with other specific needs of the psychologist who intends to become a college or university teacher is woven into the entire program. In the third year, the student will have the opportunity to teach a small section of introductory psychology under close supervision of the staff and will be

enrolled in a teaching seminar that has among its goals a deepening of the student's appreciation of the objectives and problems of teaching in the liberal arts.

The student's guidance committee will counsel with him to help plan an effective graduate program, which will typically require four years. In addition to the areas stressed in the core training shared by all students, i.e., methodology and statistics, history, theory, and systems in psychology, and teaching and the communication process, each student's program will include an emphasis upon psychological and psychosocial themes. To this end, work outside the department may be recommended when appropriate. Depth in a particular area may be obtained by independent study and research conducted under the supervision of a staff member, as well as by participation in the graduate offerings listed in Group II below. Psychology 895, 896, Reading and Research in Psychology, is specifically designed to serve this purpose.

Prior to his 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 as part of the student's program. Detailed information concerning language requirements and the qualifying examination for advancement to candidacy for the doctoral 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, he must submit Graduate Record Examination scores on the verbal and quantitative sections of the aptitude test and his 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. He need not necessarily have been an undergraduate major in psychology. However, before beginning his graduate career proper, he must have completed a minimum of 15 undergraduate credits in psychology, including courses in elementary statistics, experimental psychology, learning theory, and systematic psychology.

Preference in admission will be given to those who have recently received their bachelor's degree. Only under unusual circumstances will admission be granted to applicants who already hold a master's degree.

## 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 guidance committee, his 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 his background in the field. Graduate credit for a 700 series course is permitted only with the previous approval of the student's adviser.

### 744. Theories of Personality

The major theories of personality, with an examination of clinical and research literature as it is related to the nature and development of personality. Mr. Sibley. Prerequisite: Psychology 402. 3 credits.

### 754. Abnormal Psychology

A systematic examination of abnormal behavior patterns. The neuroses, psychoses, and character disorders are considered in detail, in terms of their etiology, symptoms and dynamics, and

treatment. Mr. Klinger. Prerequisite: Psychology 402. 3 credits.

### 758. Psychology of Learning

An evaluation of contemporary theories of learning. Attention is given to the historical antecedents of current theories, their experimental support and practical implications. Mr. Haslerud. Prerequisite: Psychology 402. 3 credits.

### 760. Psychology of Motivation

Motivational constructs are studied in relation to contemporary theories of behavior. The role of motivational variables is considered in relation to such other areas of psychology as learning, perception, and personality. Mr. Shor. Prerequisite: Psychology 402. 3 credits.

### 776. Comparative Psychology

Appraisal of the similarities and differences in the behavior of infrahuman organisms as an aid to understanding the evolution of complex behavior. The comparative method is applied to the study of such topics as instinct, consciousness, reasoning, judgment, social influence, and abnormal behavior. Mr. Hagstrom. Prerequisite: Psychology 402. 3 credits.

### 778. Physiological Psychology

Behavior as it is related to the physiological structure and function of the organism. Special attention is given to sensory, neural, and glandular functions as organic bases for factors such as motivation, emotion, and learning. Mr. Hagstrom. Prerequisite: Psychology 402. 3 credits.

### 780. Social Psychology

The social factors affecting perceptual-cognitive processes, learning, motivation, and the behavior of man in the social system. Mr. Haaland. Prerequisite: Psychology 402. 3 credits.

### **783. Systematic Psychology**

An evaluation of the numerous approaches to the study of behavior that exist within contemporary psychology. Historical perspective is given by attention to the major antecedents in philosophy, theology, and the physical sciences, and their relationship to the subsequent development of schools and systems of psychology. Mr. Watson. Prerequisite: Psychology 402. 3 credits.

### **789. Special Topics in Psychology**

Taught by a different staff member each year. The instructor will present advanced material in an area in which he has developed specialized knowledge through research and special study. Students may repeat the course, but may not duplicate areas of specialization. Staff. Prerequisite: 15 credits in psychology and/or permission of instructor. 3 credits.

## **Graduate Seminars in Psychology**

**Group I (To be taken by all first year students)**

### **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.

### **803-804. History, Theory, and Systems in Psychology**

The nature of science, directed toward increasing the student's awareness of both the strengths and limitations of the approach that characterizes psychology as a behavioral science. Attention is given to the philosophical bases upon which psychological research rests, the nature of psychological inquiry, the history of the study of behavior, and the evolution of theory building in psychology. Mr. Watson. 3 credits.

### **809-810. Research Methodology and Statistics I, II**

Research techniques and methodology in psychology. The first two semesters stress statistical and design problems, considering such topics as probability theory, the theory underlying statistical inference, parametric and non-parametric tests of significance, analysis of variance, and the appropriate use of various basic and complex designs. The multivariate techniques of multiple regression and discriminant analysis are examined. Prerequisite: Psychology 567 and 568 or their equivalents. Mr. Forsyth. 3 credits.

### **811. Research Methodology and Statistics III**

A continuation of Psychology 809-810, covering such topics as survey research, field studies, content analysis, and the relationship between research methodology and the philosophy of science. Mr. Forsyth. 3 credits.

## **Group II**

### **815. Developmental Psychology**

The genesis and development of behavioral and psychological processes as they contribute to an understanding of: (1) general behavior theory, and (2) the individual at various stages of development. The antecedents, the contemporary determinants, and the process of behavior change are investigated through the examination of selected developmental theories. The current problems and methods of research in psychological development are considered. 3 credits.

### **820. 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. Mr. Forsyth. 3 credits.

**835. Advanced Psychopathology**

The current literature is utilized to gain perspective on the etiology and dynamics of the major forms of pathological behavior. Various theoretical orientations are examined with regard to their implications for the psychotherapeutic process. Mr. Klinger. Prerequisite: Psychology 754 or its equivalent, or permission of instructor. 3 credits.

**836. Cognitive Processes**

The more complex processes that characterize man. Concept formation, problem solving, creative thinking, and the relationship between cognition and effective behavior are among the topics examined in depth. Mr. Shor. 3 credits.

**838. Theories of Behavioral Change**

An examination of man's behavior in the process of problem-defining and problem-solving. Recognizing that solutions to problems are based on the definitions of problems, the course examines the process by which problems are defined. The essential nature of functional fixedness or set in problem-solving is examined in relation to insight and creativity. The defining and solving of problems is related to changes in the individual, the organization, and the nation. The course recognizes that man's experiences and his actions are the result of how he defines and attempts to solve problems. Mr. Klinger. 3 credits.

**841. Personality Theory**

The evolutionary development of the major personality theories, with particular reference to the theoretical, clinical, and experimental contributions to current theories. Mr. Jervis. 3 credits.

**843. Psycholinguistics**

Issues relevant to the development, structure, and functions of language.

Topics include the problem of meaning, acquisition of grammar by the child, personality and voice, and the inter-relationship of language and culture. Mr. Sibley. 3 credits.

**851. Advanced 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. Mr. Haaland. Prerequisite: Psychology 780 or its equivalent. 3 credits.

**862. Psychology of Perception**

Experiments and theory concerning the organism's discrimination and interpretation of its apparent environment. An examination is made of perceptual models in learning and other areas of psychology. The course culminates in independent perceptual experiments carried out individually by each student. Mr. Haslerud. 3 credits.

**865. 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. Mr. Hagstrom. Prerequisite: Psychology 778 or its equivalent. 3 credits.

**868. Evaluation of the Therapeutic Process**

The process of psychotherapy is examined in relation to relevant research findings. The role of the psychotherapist's working theory is made explicit by showing its effect upon inferences made, goals set, and methods employed in changing the client. The student learns methods of evaluating various theoretical positions, including the identification of

basic assumptions that underlie them. He is encouraged to identify the basic assumptions upon which he bases his own theoretical position. Mr. Jervis. 3 credits.

### **370. Advanced Psychology of Learning**

Problems in conditioning and other forms of learning. Emphasis is given to the evaluation of current experimental and theoretical literature. Mr. Rutledge. Prerequisite: Psychology 758 or its equivalent. 3 credits.

### **Group III**

#### **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. Mr. Erickson. 5 credits.

#### **895, 896. Reading and Research in Psychology**

As part of his 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. 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 either in a master's thesis or a paper of publishable quality. 6 credits.

#### **999. Doctoral Research**

**Group IV (Graduate courses offered primarily for students enrolled in other graduate programs)**

#### **822. Case Studies in Counseling**

Case studies are used to illuminate the differences among a variety of personality theories and counseling techniques. The seminar is designed to help develop an appreciation of the complexities of human behavior, to gain increased respect for the integrity of individuals and their difficulties in revealing themselves to a counselor, and to understand better the difficulties encountered in applying theoretical knowledge to the counseling situation. Mr. Carroll. 3 credits. (Offered only in the summer.)

#### **823. Individual Testing**

Training in the administration, scoring, and interpretation of individual tests of intelligence. Such instruments as the Wechsler Adult Intelligence Scale, the Stanford-Binet, and the Wechsler Intelligence Scale for Children will be critically analyzed. Each student will be required to purchase one set of test materials. Miss Riggs. Prerequisite: permission of instructor. (Adequacy of

the student's background in statistics, measurement, and personality theory will be evaluated by the instructor.)  
1 lecture; 1 laboratory; 4 credits.

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## Resource Economics (21)

James R. Bowring, *Chairman*

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Admission to graduate study in Resource Economics may be granted those who have satisfied the requirements for admission to the Graduate School and present evidence of satisfactory undergraduate training. Normally this will include nine or more credits in economics, including resource or agricultural economics, as evidence of aptitude for advanced training in the field. Candidates for the Master of Science degree will be required to pass a final examination. An acceptable thesis is normally a requirement for the degree, but approved course work may be substituted for the thesis.

### 611. Public Policy for Natural Resource Use

A history of legislation dealing with land acquisition policies; private and public conflicts influencing land use; economic principles of resource allocation. Specific legislation dealing with water, forestry, land for agriculture, fishing, outdoor recreation. 3 credits.

### 706. Economics of Resource Development

Some of 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: Economics 401. 3 credits.

### 708. Research Methods in Social Sciences

Designed to teach the scientific method of research to advanced students. The meaning of logic and the scientific method and the application of research techniques to identifying and solving problems. Prerequisite: 3 hours of statistics. Mr. Drew. 3 credits.

### 715. Linear Programming Methods

Setting up and solving problems by the simplex and distribution methods; variation in linear programming methods with applications, nonlinear programming, discrete programming, and solving input-output and game theory problems. Applications to firm and aggregate economic analysis. Prerequisite: Mathematics 407 or permission of instructor. Mr. Andrews. 3 credits.

### 795-796. Investigations in Resource Economics

Special assignments in readings and problems to satisfy the student's needs. Staff. 1-3 credits.

### 804. Economics of Production and Resource Use

Principles of choice, resource use, and production under perfect and imperfect knowledge. The economic theory of resource allocation and the use of this theory in problem solving. Resource-product relationships, nature of cost, returns to scale, factor valuation and pricing, uncertainty, and interfirm relations. Mr. Andrews. 3 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. Mr. Bowring. 3 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. 3 credits.

**895-896. Investigations in Resource Economics**

Human resource development, legal problems in resource development, economics of outdoor recreation, community development. Staff. 3 credits.

**897-898. Seminar in Agricultural and Resource Policy**

Presentation and discussion of reports on public policy issues associated with agriculture and resource development. Staff. May be repeated. 1 credit.

**899. Thesis**

To be arranged. 6-10 credits.

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## Sociology (68)

Stuart Palmer, *Chairman*

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The Department of Sociology offers a program of graduate study leading to the degrees of Master of Arts and Doctor of Philosophy. The Master of Arts curriculum is largely designed to give the student the opportunity to acquire professional competence in the core areas of theory and methodology, while the Doctor of Philosophy program presents the candidate with three substantive areas for possible specialization: social disorganization, social psychology, and comparative institutional analysis. Within the context of a curriculum principally organized 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 and one minor area for intensive study, which may in specified cases extend to work in contiguous disciplines. In designing the program most appropriate to the individual, his advisers 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 dissertation topic is thus limited only by the areas of expertise available among departmental faculty members.

To be awarded the Master of Arts degree the candidate must fulfill the following requirements:

(1) Complete satisfactorily 24 hours of graduate level course work, including Sociological Theory I and II and Sociological Methods I and II.

(2) Pass a two-hour oral examination on theory and methodology.

(3) Demonstrate proficiency in translating into English sociological writings in a foreign language.

(4) Write an acceptable Master's thesis. To be awarded the Doctor of Philosophy degree the candidate must fulfill the following additional requirements:

(1) Complete satisfactorily at least one full year of course work after the Master of Arts degree, including Sociological Theory III and Sociological Methods III, as well as the residence requirement of three year's work after the Bachelor of Arts degree.

(2) Pass an oral and written examination in his major and minor areas of specialization.

(3) Demonstrate proficiency in a second foreign language.

(4) Write and defend an acceptable doctoral dissertation.

In planning his program the student will be advised, partly on the basis of an initial comprehensive examination, during the first year of graduate study by an assigned faculty member and thereafter by a guidance committee.

Instructors filling these functions will also ordinarily be found with others as members of specially appointed committees for the direction and assessment of the student's 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 knowl-



edgeability and competency peculiarly his own. In the absence of other obligations, he is expected to enroll during each semester in three graduate courses until he has completed at least 12 such courses, outside of preparation of thesis and dissertation. He will be permitted to take courses outside the department or below the 800 level within the department only with the express permission of his adviser.

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 the other social sciences, and others who have had a minimum of 18 credits in sociology, are regarded as suitable candidates for admission; but in some cases the comprehensive examination used to assess first-year students may also be required for admission. 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 will, however, be given full consideration.

#### **701. Statistics**

Use of elementary statistical techniques in analysis of prepared data. Topics include probability, discrete and continuous probability distribution, distributions of sample statistics, small sample theory, elementary analysis of variance, regression, correlation, and the chi square. 3 credits.

#### **702. Quantitative Methods of Social Research**

Analysis of research problems; designing field studies and experiments; demonstration and practice in sampling, schedule construction, and interviewing techniques. Students not majoring in sociology nor enrolled in the social service curriculum may be admitted by

permission of instructor. Prerequisite: Sociology 701. 3 credits.

#### **703, (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. 3 credits.

#### **711, 712. Development of Sociological Theory**

Social thought from Plato to the present.

First Semester: the works of selected individuals from Plato to Comte.

Second Semester: the nineteenth century European social philosophers; the ideas of U. S. social scientists, especially their contributions to present day sociological thought. Students not majoring in sociology may be admitted by permission of instructor. 3 credits.

#### **727. Public Policy in Social and Labor Legislation**

American social and labor legislation of the recent decades and provide an opportunity to study the way in which American economic and human values have been implemented and modified by law. Attention will be given to legislation and private industry programs in social security, reemployment, unemployment insurance, health services, training and retraining and fair employment practice. Lectures, discussion, assigned reading, and individual student projects. Prerequisite: one year's work in economics or sociology. 3 credits. (Also offered as Economics 727.)

#### **740. Culture Change**

Various types of society leading to the development of a theory of culture change. Descriptive studies of institutions as well as theoretical materials selected from the writing of Comte. Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. Prerequisite: Sociology 400 or permission of instructor. 3 credits.

### **743. Social Movements**

The factors related to the origin and development of reforms, revolutionary, religious, and other social movements. Generalizations concerning the organizations, structure, tactics, and leadership of social movements. The purposes and consequences of selected movements, as well as the relationships between social movements and social change. Prerequisite: Sociology 400. 3 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. 3 credits.

### **755. Ethnography of Southeast Asia**

The geographical, racial, cultural, and historical factors in the development of the area, together with detailed examinations of selected peoples and aspects of their cultures. Prerequisite: Sociology 411 or permission of instructor. 3 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 inter-relationship of population and society. 3 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 behavioral systems. Prerequisite: permission of instructor. 3 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. This course is required of both Master of Arts and Doctor of Philosophy candidates. Prerequisite: Sociology 701 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. This course is required of both Master of Arts and Doctor of Philosophy candidates. Prerequisite: Sociology 701 and 702 or their equivalent or permission of instructor. 4 credits.

### **803. Sociological Methods III. Special Problems in Methods and Statistics**

Attention is focussed 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; survey design and analysis. Doctor of Philosophy candidates are required to take at least one semester of this course. Prerequisite: Sociology 801 and 802. 4 credits.

### **811. Sociological Theory I**

The content, presuppositions, and implications of the body of sociological theory, exemplifying the full range of sociological inquiry. This course is required for both Master of Arts and Doctor of Philosophy candidates. Prerequisite: Sociology 711 and 712 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. This course is required for both Master of Arts and Doctor of Philosophy candidates. 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; classical social theory. Doctor of Philosophy candidates are required to take at least one semester of this course. Prerequisite: Sociology 711 and 712 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. 3 credits.

### **830. The Small Group**

The small group as a unit for sociological study, for the testing and the developing of hypotheses. Both the behavioral 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 structure shall be of particular interest. 3 credits.

### **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. 3 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. 3 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: introductory undergraduate course in demography or permission of instructor. 3 credits.

### **871. 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. 3 credits.

### **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 Anthropology, (4) Culture Change, (5) Culture and Personality, (6) Deviant Behavior, (7) Ethnology, (8) Population, (9) Rural-Urban, (10) Social Control, (11) Social Differentiation, (12) Social Movements, (13) Social Psychology, (14) Social Research, (15) Social Theory. Pre-

requisite: 12 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. 3 credits.

**899. Master's Thesis**  
Usually 6 credits, but up to 10 credits when the problem warrants.

**999. Doctoral Research**

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## Soil and Water Science (23)

Allan B. Prince, *Chairman*

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Before students are admitted to graduate study in Soil and Water Science they must have had an adequate preparation in the biological and physical sciences. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and his thesis.

The Department of Soil and Water Science cooperates with the Department of Chemistry in areas of mutual research interest. Students interested in a Soil and Water Chemistry Option in the Chemistry Doctor of Philosophy program should refer to page 41 of this catalog.

**701. Methods of Soil Analysis**  
Principles and practice of the more important physical and chemical methods of soil analysis, including sampling technique, particle size distribution, moisture retention, rheological properties, particle density, volume weight, cation exchange capacity, mineral element analysis. Opportunity for experience in the application of flame photometry, spectrophotometry, and isotopic tracer techniques to soil analytical problems.

Mr. Prince and Mr. Gee. Prerequisite: Chemistry 403-404 and Physics 401-402 or their equivalent. 1 lecture; 2 laboratories; 3 credits. (Alternate years; offered in 1968-1969.)

**702. Physics and Chemistry of Soil**  
Physical and chemical properties of soils; their measurement and relation to structure, water movement, temperature; and liberation absorption, and fixation of elements in soils. Mr. Prince and Mr. Gee. Prerequisite: Chemistry 401-402 or 403-404 and Physics 401-402 or their equivalent. 3 credits.

**703. Soil and Water Engineering**  
The hydrologic cycle, hydrograph analysis, estimating volume of run-off surface and subsurface drainage including principles of discharge measurement, design of small watershed dams, erosion control structures, irrigation systems. Mr. Byers. 3 credits.

**704. Soil Classification and Mapping**  
The genesis, morphology, classification, and mapping of soils. Mr. Peterson. Prerequisite: Soil and Water 501 and Geology 401 or 407 or permission of instructor. 2 lectures; 1 laboratory; 3 credits. (Alternate years; not offered in 1968-1969.)

**710. Ground-Water Hydrology**  
Basic principles with emphasis on physical properties of water-bearing materials, Darcy's law and the coefficient of permeability, selected steady and non-steady state solutions of the basic flow equation for groundwater motion, well hydraulics, and chemical quality of water. Mr. Hall. Prerequisite: Soil and Water 703 or permission of instructor. 3 credits.

**712. Hydrology Laboratory**  
Includes work with fluid and electric analog models, flow measurement, seismic and resistivity techniques, chemical determinations, preparation and interpretation of water-level maps, and

analysis of well tests. Mr. Hall and Mr. Byers. Prerequisite: Soil and Water 703 and 710 (concurrently). 2 laboratories; 2 credits.

### 797-798. Soil and Water Science Seminar

Library work and discussions on special phases of soil and water problems. Staff. Required each semester of seniors and graduate students majoring in soil and water science; elective for other qualified students. 1 credit.

### 801. Advanced Soil Physics

The physics of unsaturated water flow. Potential and diffusion theory applied to infiltration and drainage in both uniform and nonuniform porous media. Problems of multicomponent flow including water and heat transfer interactions. Permission of instructor. Mr. Gee. 3 credits.

### 802. Advanced Soil Chemistry

Lectures, discussion, and problem work in laboratory. Physical chemistry of soils and soil colloidal phenomena. Anion and cation exchange mechanism in soils. Theories of swelling. Crystallographic properties of the clay colloids and their relation to cation and anion exchange. The nature of soil acidity. Oxidation-reduction phenomena in soils. Permission of instructor. Mr. Prince. 3 credits.

### 803. Advanced Ground-Water Hydrology

Advanced treatment including velocity potential differential form of Darcy's law, differential equations of ground-water motion, elastic properties of aquifers, leaky aquifer theory, and selected problems in well hydraulics. Mr. Hall. Prerequisite: Soil and Water 710 or permission of instructor. 3 credits.

### 804. Hydrochemistry

Concerned mainly with fresh waters at or near the surface of the earth. The waters are treated from a chemical

viewpoint an analogous to low pressure, low temperature, dilute aqueous solutions. Major topics include buffering mechanisms, oxidation-reduction reactions, ion exchange, and chemical systems involving silicate and carbonate minerals. Particular emphasis given to methods of interpretation. Mr. Hall. Prerequisite: Chemistry 633-684 or equivalent. 2 lectures; 1 laboratory; 3 credits.

### 895-896. Research Techniques

Offered in: (1) Soil-Plant Relationships, Mr. Peterson. (2) Physics and Chemistry of Soils, Mr. Prince and Mr. Gee. (3) Hydrology, Mr. Hall and Mr. Byers. (4) Chemistry of Water, Mr. Hall. Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

### 899, (899). Thesis

A thesis study of some phase of soil and water science is required of all candidates for an advanced degree. 6-10 credits.

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## Spanish and Classics

Charles H. Leighton, *Chairman*

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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.

To be admitted to graduate study for the Master of Arts degree in Spanish, a student must have met requirements substantially equal to those set up for an undergraduate major in that language at the University. In addition, all candidates for admission to the graduate program in Spanish must take the general Graduate Record Examination and the advanced test in Spanish. To obtain the degree, the student must fulfill a course requirement and submit an acceptable thesis.

To satisfy the course requirement, he must complete at least 24 credits of

graduate work selected from the courses listed below (6 credits are granted for the thesis thus completing the total of 30 established by the Graduate School as requisite for the degree). Of the 24 credits, 18 must be in Spanish and 6 may be selected from the courses in general languages or from courses in a related literature.

To take a course numbered 850-898, a student must register for the corresponding undergraduate course numbered 750-798, pass it with a grade of B or better, do supplementary work assigned by the instructor and prepare a paper of graduate-quality on a topic assigned by the instructor. No student may register for a graduate course if he has already taken the corresponding undergraduate course here or its equivalent elsewhere.

Before undertaking work on the thesis, the student must pass a comprehensive written examination. The examination 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 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 before April 20 of the academic year in which the degree is to be granted. 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 30 semester hours of work at the graduate level. Since it is intended for teachers already in service, courses leading to this degree will normally be chosen from Summer Session offerings. Secondary school teachers interested in this degree should consult the Department Chairman.

## Spanish (62)

### 751. Spanish Literature up to 1600

Readings and discussion of the great human creations of early Spanish Literature, such as *El Poema de Mio Cid*, *El Libro de Buen Amor* and *La Celestina*, and their social and historical background. The course will cover Spanish literature before Cervantes. Conducted in Spanish. Prerequisite: Spanish 505 or equivalent. 3 credits.

### 752. 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, Caleron, and the poetry of Lope, Gongora and Quevedo. Development of the prose of the period. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

### 754. Cervantes

The development of Cervantes' literary art. Reading and discussion of selection from all the major works of Cervantes. Comprehensive study of the *Quijote*, its originality and significance, its antecedents, its religious, philosophical and sociological aspects, and its artistic structure. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

### 755. Literature of the Nineteenth Century

Preliminary survey of the eighteenth century and readings and discussion in the main literary movements of the nineteenth century. Selections from Quintana, Espronceda, Zorrilla, Larra, Duque de Rivas, Bécquer, Pérez Galdos, Valera, Pereda, Clarin, and Echegaray. Social and historical background of Spain in relation to nineteenth century thought in Europe. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

**756. Contemporary Spanish Literature**

Starting with the generation of 1898, readings and discussion of the works of such writers as Unamuno, Azorin, Baroja, Machado, J. R. Jiménez, Ortega y Gasset, Garcia Lorca, Pérez de Ayala, Benavente, Casona, plus a survey of Spanish literature and thought since 1939. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

**765, 766. Spanish American Literature**

The main themes of Spanish American literature studied in the works of its most representative authors and against the historical, social and geographical background of the New World. Conducted in Spanish. Prerequisite: Spanish 506 or equivalent. 3 credits.

**795,796. Special Studies in Spanish Language and Literature**

Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics that may be selected by instructor and student in conference are: (1) eighteenth, nineteenth, or twentieth century literature in Spain; (2) literature and civilization in Spain in the Golden Age; (3) the literature of individual Latin-American countries. Staff. Conducted in Spanish. Prerequisite: permission of Department Chairman. Variable credit.

**851. Spanish Literature Up to 1600**  
Prerequisite: Spanish 505 or equivalent. 3 credits.

**852. Drama and Poetry of the Siglo de Oro**  
Prerequisite: Spanish 506 or equivalent. 3 credits.

**854. Cervantes**  
Prerequisite: Spanish 506 or equivalent. 3 credits.

**855. Literature of the Nineteenth Century**  
Prerequisite: Spanish 506 or equivalent. 3 credits.

**856. Contemporary Spanish Literature**  
Prerequisite: Spanish 506 or equivalent. 3 credits.

**865, 866. Spanish American Literature**  
Prerequisite: Spanish 506 or equivalent. 3 credits.

**895, 896. Special Studies in Spanish Language and Literature**  
Prerequisite: permission of Department Chairman. 3 credits.

**899. Master's Thesis**  
6 credits.

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## Technology (79)

John B. Hraba, *Acting Dean*

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**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 and probability distributions. Correlation and regression analysis. Design of experiments; factorials, fractional factorials, designs for process optimization. Introduction to quality control; construction and analysis control charts for variables and attributes; statistical aspects of tolerance. 3 credits.

**780. Engineering Analysis**  
The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. Prerequisite: permission of instructor. 2-3 credits.

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## Zoology (70)

Paul A. Wright, *Chairman*

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To be admitted to graduate study in Zoology, a student must have completed an undergraduate major in biology or zoology. In addition to a basic array of zoology courses, botany, chemistry, mathematics, physics and, for those students intending to apply for the Doctor of Philosophy degree, two foreign languages (usually French and German) are also necessary. Students lacking one of these requirements may occasionally be admitted but will be required to complete certain courses which do not give graduate credit.

Candidates for the Master's degree in Zoology will be required to pass a written examination covering their general knowledge of the biological sciences. A Master's student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree.

Students who apply for admission to the Doctor of Philosophy program must demonstrate to the satisfaction of the guidance committee proficiency in reading zoological literature of two foreign languages, usually French and German, and demonstrate to the doctoral committee a broad basic knowledge of the field of Zoology and cognate sciences by means of oral and written qualifying examinations. Before being finally accepted as a doctoral student, and preferably during his master's program, each student must demonstrate indication of his research capabilities. Students who begin their graduate work at New Hampshire will ordinarily meet this requirement by completing a special problem (Zoology 895, 896), acceptable to the proposed major professor, or a master's thesis (Zoology 899).

### 701, (701). Principles of Ecology

The interrelationships of plants and animals with both their living and non-

living environments. Energy relationships, limiting factors, community organization, succession, and biogeography. Staff. Prerequisite: Zoology 412 or equivalent. 3 credits.

### 704. Comparative Endocrinology

The various endocrine organs, vertebrate and invertebrate, with particular emphasis on endocrines which relate to physiology of reproduction. Mr. Wright or Mr. Tillinghast. Prerequisite: vertebrate anatomy and physiology, organic chemistry. 3 credits.

### (706), 706. Genetics

A general course on the principles of genetics. Includes basic Mendelism, linkage, quantitative variation, mutation and population genetics. Introduces the chemical basis of heredity, action of the gene, and application of Mendelian principles to animal and plant breeding. Mr. Hoornbeek. Prerequisite: Zoology 412 or equivalent. 3 credits. Laboratory optional for non-majors for one additional credit, but required of zoology majors.

### 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. Prerequisite: general zoology and zoology 508. 2 recitations; 2 laboratories; 4 credits.

### (712). Mammalogy

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. Prerequisite: general zoology and zoology 508. 2 lectures; 1 laboratory; 3 credits.

### (713). Animal Behavior

Individual and group behavior patterns of animals with the role of anatomy,



physiology, and prior experience emphasized. Techniques and the practical application of the study of animal behavior. Mr. Franço. Prerequisite: one year of zoology. 3 credits.

#### **(715). Natural History of Marine Invertebrates**

A field and laboratory course aimed at acquainting 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 (collections and observation) will constitute a major part of the course and the student must be prepared to assume some travel expense. Mr. Moore and Mr. Croker. Prerequisite: general zoology. 1 lecture; 3 laboratories; 4 credits. (Also offered in Summer Session.)

#### **721. Parasitology**

An introductory course on 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. 2 lectures; 2 laboratories; 4 credits.

#### **725. General Physiology**

The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction. Mr. Sasner and Mr. Tillinghast. Prerequisite: one year of zoology and organic chemistry. 3 lectures; 1 laboratory; 4 credits.

#### **729. Vertebrate Morphogenesis**

The fundamental principles of vertebrate growth and development including embryology, metamorphosis, regeneration and oncology. Mr. Foret. Prerequisite: general zoology. 2 lectures; 2 laboratories; 4 credits.

#### **730. Elements of Histology**

The microscopic anatomy of principal tissues and organs of vertebrates. Mr.

Bullock. Prerequisite: Zoology 508 or equivalent or permission of instructor. 2 lectures; 2 laboratories; 4 credits.

#### **795, 796. Special Problems in Zoology**

Election of one or more sections of this course provides opportunity for advanced study. Work may involve reading, laboratory work, organized seminars, and/or conferences. Prerequisite: permission of Department Chairman and staff concerned. 1-6 credits. (Limit of 12 credits from the sections of this course.) Section numbers and subject-matter fields are (1) Bibliographic Methods, (2) Ecology, (3) Endocrinology, (4) Evolution, (5) Developmental Biology, (6) Genetics, (7) Histology, (8) History of Zoology, (9) Invertebrate Zoology, (10) Physiology, (11) Vertebrate Zoology, (12) Zoogeography, (13) Zoological Techniques, (14) Parasitology, (15) Histochemistry, (16) Protozoology, (17) Systematics, (18) Animal Behavior.

#### **801. Freshwater Ecology**

An introduction to some of the chemical, physical, and biological facets of the special relationships between freshwater organisms and their environment. Laboratories will include limnological techniques and others necessary for analyzing the variations in freshwater habitat. Mr. Sawyer. Prerequisite: Zoology 701; courses in physics, chemistry, invertebrate and vertebrate zoology, geology, algology, and aquatic entomology are desirable. 2 lectures; 2 laboratories; 4 credits. (Not offered in 1968-1969.)

#### **(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 afternoon, or weekends. Travel will be at student's expense, and should not exceed \$30 for the course. Mr. Croker. Prerequisite: Zoology 701 or equivalent. 2 lectures; 2 laboratories; 4 credits.

### 818. Histochemistry

The principles and techniques for localization of inorganic and organic substances in tissue sections. Prerequisite: Zoology 730 and a knowledge of microtechnical procedures. 2 lectures; 2 laboratories; 4 credits.

### (820), (821). Invertebrate Zoology

The morphology, phylogeny, and natural history of the major invertebrate groups. Mr. Swan, Mr. Moore, and Mr. Croker. Prerequisite: general zoology; Zoology 715 desirable. 2 recitations; 2 laboratories; 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. 2 lectures; 2 laboratories; 4 credits. (Alternate years; not offered in 1968-1969.)

### 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. Prerequisite: previous training in parasitology, histology, and ecology desirable. 2 lectures; 1 laboratory; 3 credits. (Not offered in 1968-1969.)

### (824). Advanced Parasitology

The basic principles of parasitism as exhibited by various groups of Protozoa and helminths. Emphasis on life cycles, ecology, and host-parasite relationships.

Mr. Bullock. Prerequisite: Zoology 721. 2 lectures; 2 laboratories; 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 725. 3 lectures; 1 laboratory; 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. Prerequisite: Zoology 820, 821. 2 recitations; 2 laboratories; 4 credits. (Offered in Summer, 1969.)

### 836. Advanced Genetics

Genetic recombinations and mutations. Structure and physiological action of the gene. Mr. Hoornbeek. Prerequisite: Zoology 706 or equivalent. 3 credits.

### 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/or conferences. Prerequisite: permission of Department Chairman and staff concerned. 1-6 credits. Sections of this course are the same as those listed under Zoology 795, 796.

### 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. 1 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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