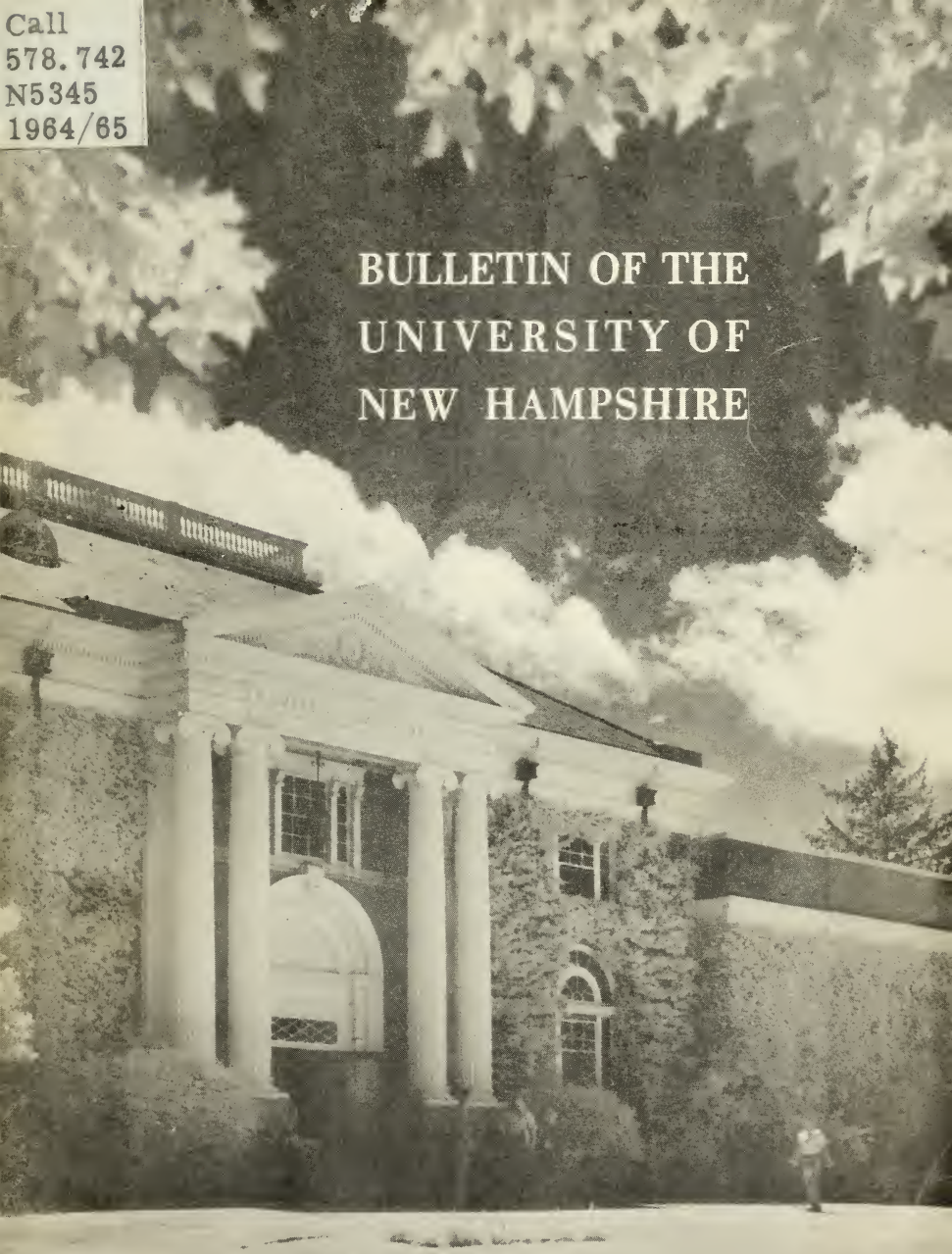
BULLETIN OF THE UNIVERSITY OF NEW HAMPSHIRE



Graduate School Issue—1964-1965

The Graduate School

of the

UNIVERSITY OF

NEW HAMPSHIRE

1964-1965

VOL. LV DECEMBER 1963 NO. 4

The Bulletin of the University of New Hampshire is published three times in January, twice in November and December, and once in September, March, and April. Second-class postage paid at Durham, N. H.

University Calendar

1964

Summer Session

June 22, Monday	Registration, eight-week session and first four-week session
June 23, Tuesday	First day of classes
July 6, Monday	Registration, six-week session
July 7, Tuesday	First day of classes
July 20, Monday	Registration and first day of classes, second four-week session
August 14, Friday	Classes end

Semester I

August 27, Thursday	Last day for application for admission to graduate study for Semester I
September 18, Friday	First faculty meeting
September 22, Tuesday	Registration
September 23, Wednesday	Classes start
November 24, Tuesday	Thanksgiving recess starts, 7:00 p.m.
November 30, Monday	Classes resume, 8:00 a.m.
November 30, Monday	Last day for filing applications for graduate scholarships for second semester
December 18, Friday	Christmas recess starts, 7:00 p.m.

1965

January 4, Monday	Classes resume, 8:00 a.m.
January 4, Monday	Last day for application for admission to graduate study for Semester II
January 23, Saturday	Examinations begin
January 30, Saturday	Examinations end

Semester II

February 8, Monday	Registration
February 9, Tuesday	Classes start
February 12, Friday	Last day for filing applications for graduate scholarships for academic year 1965-1966
April 2, Friday	Spring recess starts, 7:00 p.m.
April 12, Monday	Classes resume
May 5, Wednesday	Last day for filing applications for 1965 Summer Session graduate scholarships
May 7, Friday	Last day for presenting Ph.D. dissertation at Graduate School Office, if degree is to be granted in June
May 21, Friday	Last day for final Ph.D. oral examination, if degree is to be granted in June
	Last day for presenting completed Master's thesis to Graduate School Office, if degree is to be granted in June
May 29, Saturday	Examinations start
June 5, Saturday	Examinations end
June 13, Sunday	Commencement

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Regulations of the Graduate School

General Information

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.

Graduate programs are offered by the following departments: Animal Sciences, Biochemistry, Biology, Botany, Chemical Engineering, Chemistry, Civil Engineering, Electrical Engineering, Entomology, Forestry, Home Economics, Mathematics, Mechanical Engineering, Microbiology, Physics, Plant Science, and Zoology leading to the Master of Science degree; Economics, English, Foreign Languages and Literatures, Government, History, Mathematics, Psychology, Resource Economics, and Sociology leading to the Master of Arts degree; Education leading to the Master of Education degree; and Agricultural Education leading to the Master of Agricultural Education degree. There is also a program leading to the Master of Science for Teachers degree in the Chemistry, English, Foreign Languages and Literatures, Mathematics, and Physics departments and a program leading to the Master of Public Administration degree in the Government Department.

Graduate programs leading to the degree of Doctor of Philosophy are offered in the following departments: Botany, Chemistry, Mathematics, Microbiology, Physics, Plant Science (Horticulture), and Zoology.

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.

General Regulations

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 with benefit the courses desired. A candidate for admission must have had a cumulative undergraduate record of not less than a 2.5 grade-point average on a grading scale in which A equals 4.0, B equals 3.0, C equals 2.0, D equals 1.0, or the equivalent, for his undergraduate program of study. In addition the candidate for admission may be required to take an achievement test, where the department in which the candidate plans to do his work so requires. These general requirements for admission to the Graduate School are in addition to the special requirements set up by individual departments or to those of the program leading to the Master of Science for Teachers degree that presupposes certification as a teacher or its equivalent. For the individual departmental requirements, see the description under the departmental offerings in this bulletin.

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. The application must be accompanied by two official transcripts of the student's undergraduate work and of any previous graduate work, and by two 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 for admission to the Graduate School should be submitted before September 1 for the first semester, before January 1 for the second semester, and before May 15 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.

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 Uni-

versity 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 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 the 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 bulletin for the dates of registration.

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 600 through 899, and in the thesis, but graduate credits will not be given in any courses so numbered which are open to freshmen or sophomores.

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. Up to 20 superior students, who have been regularly admitted to the Graduate School, may be granted exemption from Summer Session tuition. Applicants are required to submit applications no later than May 15 on a special form available at the Office of the Graduate School. For complete information on the Summer Session see the Summer Session issue of the Bulletin of the University of New Hampshire.

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. Such seniors may not substitute courses for which they registered in an undergraduate program for those for which they registered in a graduate program.

Students holding the baccalaureate degree who have not been admitted to the Graduate School, but who wish to register 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 bulletin.

Tuition

The tuition is $380 a year for residents of New Hampshire, and $925 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 catalogues.

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 $17.50 per credit hour. In certain instances Graduate Assistants may be exempted from payment of tuition. Tuition for pre-doctoral students is stated in the section of this bulletin devoted to the requirements of the Doctor of Philosophy 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.

Living Facilities

In addition to 98 apartments for faculty and married students, the University operates one residence hall, Schofield House, for single graduate students which accommodates 31 men and 13 women. Room assignments to this hall are made in the order of

receipt of the applications. Requests for applications for rooms in Schofield House should be made directly to University Housing, Thompson Hall.

Off-campus accommodations are best secured by personal survey, but partial listings are maintained by the University Housing Office. The University, however, can assume no responsibility for living accommodations contracted between landlords and individuals.

The University operates on a self-service basis a modern dining hall. Regular weekly board and cafeteria service are provided at approximately $14.00.

Assistantships and Scholarships

Approximately 100 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 (a) teaching assistance, (b) research assistance, or (c) general service.

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

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

1. $2400 for the academic year for 20 hours of service per week. 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. $3360 (10 months at $240, 2 months at $880) for the fiscal year for 20 hours of service per week during 9 months, 44 hours per week for two months, with one month of vacation. Normal academic program: 9 semester hours per semester for two semesters. Exemption from payment of tuition for the regular academic year may be granted on the recommendation of the department chairman.

In addition to those already mentioned, there are assistantships in several departments which are supported by sponsored research projects. There are also teaching and research fellowships with larger stipends available to advanced students in doctoral programs.

The Graduate School also offers tuition scholarships. Up to twenty-five superior students may be granted exemption from

tuition. 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 exemption for the subsequent semester. Foreign students will be considered for scholarship awards. Applicants are required to submit an application on a special form available at the Office of the Graduate School.

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 full-time 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 and $2,800 for the second and third year 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. Applications for this Fellowship should be directed to the Dean of the Graduate School.

Graduate students also are eligible for fellowship awards granted by the National Science Foundation, the Public Health Service, the Woodrow Wilson Foundation, and other national agencies, and for fellowships awarded under the National Defense Education Act. The University participates in the National Science Foundation Cooperative Fellowship Program and in the National Science Foundation Program of Summer Fellowships for Graduate Assistants. Information concerning these programs may be obtained at the Office 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.

There are two special fellowship programs available as follows:

The Hubbard Farms Fellowship in Poultry Science is provided through the generosity of Hubbard Farms, Inc., of Walpole, N. H. The grant is made in support of the graduate and research programs of the Department of Poultry Science. The fellowship is awarded annually to a student who has been admitted to the Graduate School for major work in poultry science and who has demonstrated high scholastic ability as an undergraduate, and

is in need of financial assistance. If the student maintains high scholastic standing during his first year of graduate study, the award may be continued during the remainder of his graduate study at the University. The selection of the recipient of this award will be made by a committee composed of the Chairman of the Department of Poultry Science, the Dean of the College of Agriculture, and the Dean of the Graduate School. Applications for this fellowship should be directed to the Dean of the Graduate School.

The George F. Dwinell Memorial Fellowship Fund of the New Hampshire Cancer Society, Inc., is provided, on a yearly basis, to promote the interest of young people in investigative work on growth. Selection of the recipients of these awards is determined by a University committee. Applications should be obtained from the Dean of the Graduate School.

Requirements for the Master's Degree

For the degrees of Master of Arts, Master of Science, and Master of Agricultural Education, at least 30 credits must be earned, including a minimum of eight credits in courses, not including thesis, numbered 800-899. 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. See departmental statements for further details on requirements.

The Master of Science for Teachers degree is designed for the experienced and certified teacher who is interested in improving his understanding of the subject matter that he teaches. Thirty credits must be earned and, at the discretion of the department, a comprehensive final examination successfully passed. A departmental guidance committee plans the program, subject to the approval of the Dean of the Graduate School and a special committee of the Graduate Faculty; it also administers the final examination, if required.

The requirements for the Master of Education degree, somewhat different from those above, are listed in the course descriptions of the Department of Education.

A student will normally spend at least one academic year, or the equivalent, on the degree. No more than 12 credits, not in-

cluding 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.

Students in the Master's degree programs must earn a grade of A or B in all courses for which a letter grade is given. The grade of Cr. (credit) is given for the thesis. Any graduate student who receives a grade of below B in nine or more credits will be required to withdraw from the Graduate School.

In any department or program requiring a final examination for the Master's degree, the examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examinations for the Master's degree, and the time of these examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date in the year in which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School. Oral examining committees, when required and not otherwise provided for, 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 theses.

Whenever a thesis is printed, it must be designated as having been accepted as a Master's thesis by the University of New Hampshire.

Two copies of the approved thesis, ready for binding, shall be 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 bulletin.)

Requirements for the Doctor's Degree

The degree of Doctor of Philosophy is conferred on qualified candidates who have passed an oral and 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 given by the Departments of Botany, Chemistry, Mathematics, Microbiology, Physics, Plant Science (Horticulture), 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.

Tuition

The tuition is $380 a year for residents of New Hampshire, and $925 a year for non-residents. Any student registering for eight credits or more per semester must pay full tuition. In pursuing a program of fewer than eight credit hours per semester, he shall pay at the rate of $17.50 per credit hour. In certain instances, graduate assistants may be exempted from payment of tuition, during the academic year and the following summer period.

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. A doctoral student is defined as one who has completed 30 graduate credits with a grade of B or better, or has received a Master's degree.

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.

General Requirements

A student working for the Ph.D. degree must earn grades of A or B in all the courses required by his guidance committee. Certain courses may be taken for audit. A grade of Cr. (credit) is given for the completed dissertation.

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 has completed the requirements for foreign languages to the satisfaction of 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 thesis, 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.

University Services

The Counseling Center provides professionally qualified assistance to students who are dissatisfied with some aspect of their academic functioning or who have personal or emotional problems which interfere with their educational experience. The services of the Counseling Center are not limited to those with "serious" problems but are geared to the needs of the normal college student who seeks to achieve more personal effectiveness and greater self understanding. In addition to the direct help the Center gives to students, the staff is also available to members of the faculty and staff on a consultation basis.

The University Health Service, located in Hood House, is devoted to the protection, improvement, and maintenance of student health. Graduate students carrying 8 or more credits, and graduate assistants, are eligible for treatment. A well-equipped out-patient clinic for diagnosis and treatment of ambulatory patients and a modern infirmary of 26 beds, with private and semi-private rooms, wards, and an isolation division for communicable diseases, are constantly available for students who require care. Registered nurses are on duty at all times. Hood House is open 24 hours daily during the periods when school is in session. Individual health guidance is given through personal conferences with the University Physician.

Injury and illness which require hospital confinement other than in Hood House, services of specialists, operations, ambulance service, special nurse, or special prescriptions are at the expense of the student. Bed patients at Hood House are charged $4.00 per day. Office hours of the University Physician are from 9:00 a.m. to 4:00 p.m. daily except Saturdays and Sundays.

In addition to the health service available through Hood House, group accident and sickness insurance giving 12 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, games rooms, and meals and snacks, as well as headquarters for a number of student organizations. The receptionist reserves rooms for organizations to meet in the Memorial Union and in other University

buildings and serves 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 Student Union 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 placement services of the Testing and Placement Service are available to all degree candidates who have completed at least 12 semester hours of graduate work and have been accepted to degree candidacy by the Graduate School. The testing services, offering the Graduate Record Examination and the Miller Analogies Test, as well as other tests for graduate schools, are also available through the Service by special appointment.

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 22,000 men and women who represent New Hampshire College and University of New Hampshire classes from 1883 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 2 *ex officio* members, 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 46 UNH alumni clubs throughout the United States. A monthly magazine, *The New Hampshire Alumnus*, circulates news of students, faculty, alumni, and the University to subscribers. From offices in Alumni House on Garrison Avenue, the Association's activities are directed by a permanent Alumni Executive and his staff.

Courses of the Graduate School

Beginning with the academic year 1964-65, a new system of course numbering will go into effect. If the numerals designating a course running through both semesters are connected by a hyphen, the first semester's work or its equivalent is a prerequisite to the second. If the numerals are separated by a comma, properly qualified students may take the second semester's work without having had the first. Departments in the College of Liberal Arts have indicated the former course number following each course description.

Courses numbered 800 and above are open only to those admissible to graduate study. Courses numbered 700 through 799 are open to graduate and advanced undergraduate students. In unusual circumstances, and at the discretion of the department in which the student is admitted to graduate study, courses numbered 600-699 may be used towards the Master's degree; however, courses in this series cannot be used towards that degree if they are given in the department awarding the degree.

The Graduate School reserves the right not to offer an announced course when valid reasons arise.

Departmental Requirements and Description of Courses

Agricultural Education

William H. Annis, Program Chairman

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

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

801. Advanced Methods in Agricultural Mechanics Instruction

Agricutural 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 cr. (Offered in 1965.)

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 cr. (Offered in 1967.)

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 cr. (Offered in 1964.)

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 cr. (Offered in 1965.)

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 cr. (Offered in 1966.)

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 cr. (Offered in 1966.)

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 cr. (Offered in 1966.)

808. Organizing, Teaching, and Supervising Adult Education Programs
The techniques of organization, program planning, methods of teaching, and methods of supervision as they apply to instruction with out-of-school groups. Mr. Annis. 2 cr. (Offered in 1967.)

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 cr. (Offered in 1964.)

810. 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 cr.

811. Supervision and Administration of Vocational Education
The Federal and State requirements for vocational education programs in the secondary schools. 2-3 cr.

895, 896, 897. Projects in Agricultural Education
Individual study problems in various phases of agricultural education. *Prereq.:* Permission of staff. 2 cr.

Agronomy

(See Plant Science and Soil and Water Science)

Animal Sciences
(Dairy, Livestock, Poultry)
W. C. Skoglund, Chairman

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
The principles of Mendelian and quantitative genetics applied to livestock and poultry; selection and breeding systems in genetics improvement and their evaluation. *Prereq.:* Zool. 706 or permission of instructor. Mr. Collins. 2 lec.; 1 lab.; 3 cr

705. A Review of Animal Husbandry

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, lec. and lab.; 2 cr.

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, lec. and lab.; 2 cr.

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, lec. and lab.; 2 cr.

708. Advanced Dairy Science

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

710. Dairy Cattle Nutrition and Management

Feeding and management of dairy animals, calf feeding, raising young stock, and feeding for economical milk production. Mr. Holter. 2 lec.; 1 lab.; 3 cr.

711-712. Investigations in (Livestock, Dairy, Poultry)

Breeding: Mr. G. L. Smith, Mr. Collins, Mr. Morrow
Nutrition: Mr. G. L. Smith, Mr. Ringrose, Mr. Colovos, Mr. Holter
Management: Mr. Tirrell, Mr. Skoglund, Mr. Morrow
Diseases: Mr. Allen, Mr. Corbett, Mr. Dunlop, Mr. Strout, Mr. S. C. Smith
Products: Mr. G. L. Smith, Mr. Moore
Light Horsemanship: Mr. Tirrell

Elective only after consultation with the instructor in charge. Hours to be arranged. 1-3 cr. 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. Tirrell and Mr. G. L. Smith. 2 lec.; 1 lab.; 3 cr.

802. Meats, Livestock Markets, and Products

The essential factors in meat selection, cutting, curing, and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Mr. G. L. Smith. 2 lec.; 1 lab.; 3 cr.

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 cr.

804. Advanced Dairy Cattle Breeding

The analysis and formulating of breeding programs and to milk secretion and factors influencing the quantity and quality of milk. Mr. Morrow. 2 lec.; 1 lab.; 3 cr.

805-806. Avian Microbiology

The disease process 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. *Prereq.:* An. Sci. 602 or the equivalent. 3 cr.

807-808. Avian Histopathology

First semester: general histopathology. Second semester: the special histopathology of common diseases with emphasis on tumors and tumor formation. Mr. Dunlop and Mr. Strout. *Prereq.:* Histology or the equivalent. 3 cr.

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 cr.

811-812. Advanced Poultry Genetics

First semester: genetic and environmental variation; methods of statistical analysis fundamental to biological research, including variance components analysis and principles of partitioning hereditary variance. Second semester: principles of quantitative inheritance including changes in gene frequency, selection, inbreeding and outbreeding. Methods of estimating heritability and genetic correlations. Mr. Collins. 3 cr.

897-898. Animal Science Seminar

A survey of recent literature and research in the Animal Sciences. Staff. 1 cr. May be repeated.

899. Thesis

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

Biochemistry

Edward J. Herbst, Chairman

Students admitted to graduate study in Biochemistry are expected to have had preparation in the biological sciences, mathematics, physics, and chemistry. The candidate for the M.S. degree will be required to prepare a thesis, and to pass an oral examination covering his graduate courses and thesis.

751. General Biochemistry

The fundamental principles with emphasis on the chemical properties, principal metabolic pathways, and functions of carbohydrates, lipids, and nitrogenous compounds. Mr. Herbst and Mr. Ikawa. *Prereq.:* Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 lab.; 5 cr.

756. Physiological Chemistry and Nutrition

An introductory course with emphasis on human physiological chemistry and nutrition. Mr. Teeri. *Prereq.:* Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 lab.; 5 cr.

762. Plant Metabolism

The function, occurence, synthesis, and degradation of plant constituents; respiration and photosynthesis and their relationships to the metabolism of lipids and nitrogen compounds. Mr. Routley. *Prereq.:* Biochem. 751 or 756 or equivalent. 2 lec.; 1 lab.; 3 cr.

811. Biochemistry of Lipids

The chemistry, metabolism, and function. Mr. Smith. *Prereq.:* Biochem. 751 or 756 or equivalent. 2 lec.; 2 cr. (Alternate years; offered in 1964-65.)

821. Proteins and Amino Acids

The chemistry, metabolism, and function. Mr. Teeri. *Prereq.:* Biochem. 751 or 756 or equivalent. 2 lec.; 2 cr. (Alternate years; not offered in 1964-65.)

832. Carbohydrates

The chemistry, metabolism, and function of carbohydrates and related substances. Mr. Ikawa. *Prereq.:* Biochem. 751 or 756 or equivalent. 2 lec.; 2 cr. (Alternate years; offered in 1964-65.)

842 Nucleic Acids and Nucleoproteins

The chemistry and metabolism of nucleic acids and nucleoproteins and their distribution and function in cells. Mr. Herbst. *Prereq.:* Biochem. 751 or 756 or equivalent. 2 lec.; 2 cr. (Alternate years; not offered in 1964-65.)

872. Advanced Biochemistry Laboratory

The methods used in biochemical research. Mr. Herbst and staff. *Prereq.:* Permission of the Department Chairman. 1 lec.; 3 lab.; 4 cr.

895, 896. Graduate Projects

Staff. *Prereq.:* Satisfactory preparation in analytical, organic, and biological chemistry. Subject matter and credits to be arranged.

897, 898. Biochemistry Seminar

Presentation and discussion of recent investigations. Mr. Herbst. *Prereq.:* Permission of the Department Chairman. 1 cr.

899. Thesis

To be arranged. 6-10 cr.

Biology

Paul A. Wright, Chairman of Committee

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. With the permission of the Committee and the prospective Supervisor of the Thesis, a student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree.

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

Objectives and methods of teaching; the selection and organization of materials; the preparation of visual aids; the setting up of aquaria and other projects. The use of the field trip as a tool in teaching high school biology. Mr. Schaefer. *Prereq.:* Two years of biological sciences and Principles of Teaching. 2 rec.; 1 lab. or field trip; 3 cr. (Formerly 91.)

For listings of other courses see: Botany, Entomology, Microbiology, and Zoology.

Botany

Albion R. Hodgdon, Chairman

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 M.S. 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 Ph.D. degree must demonstrate a reading knowledge of two foreign languages, preferably French and German, early in their programs, and must complete a thesis-dissertation on some original research in Botany. The subject-matter fields for graduate study in Botany are: Systematic Botany and Plant Ecology, Mr. Hodgdon; Plant Physiology, Mr. Dunn; Plant Morphology and Anatomy, Miss Nast; Plant Pathology, Mr. Rich, and Mr. Kilpatrick; Mycology, Mr. Richards; Cytology, Mr. Schreiber.

742. Plant Ecology

Plant life and its environment, including such factors as light, temperature, soil, water, and biotic relations; associations, successions, and plant forms; plant distribution and underlying causes. Mr. Hodgdon. *Prereq.:* Bot. 1 or Bot. 3. 3 cr.

751. Plant Pathology

The nature of disease in plants, the etiology, symptomatology, and classification of plant diseases. Mr. Rich. *Prereq.:* Bot. 1 or Bio. 1. 1 lec.; 2 lab.; 3 cr.

752. Principles of Plant-Disease Control

Exclusion, eradication, protection, and immunization, and the specific, practical methods used to control plant diseases. Mr. Rich. *Prereq.:* Bot. 51. 1 lec.; 2 lab.; 3 cr. (Alternate years; not offered in 1964-65.)

753. Plant Anatomy

The anatomy of vascular plants with emphasis on tissue development and structure. Miss Nast. *Prereq.:* Bot. 1 or Bot. 3. 1 lec.; 2 lab.; 3 cr.

754. Cytology

The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Shreiber. *Prereq.:* two years each in the biological sciences and in chemistry. 3 lec.; 3 cr.

755. Advanced Systematic Botany

The principles and laws of plant classification and nomenclature; plant families, field, and herbarium work. Mr. Hodgdon. *Prereq.:* Bot. 6. Hours to be arranged. 3 cr. (Offered in 1964-65.)

756. Plant Physiology

Structure and properties of cells, tissues, and organs; absorption and movement of water; metabolism; growth and irritability. Mr. Dunn. *Prereq.:* Bot. 1 or Bot. 3, and one year of chemistry. 2 lec.; 2 lab.; 4 cr.

795-796. Investigations in (a) Systematic Botany, (b) Plant Physiology, (c) Plant Pathology, (d) Plant Anatomy and Morphology, (e) Plant Ecology, (f) Aquatic Plants, and (g) Cytology

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

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. *Prereq.:* 6 hours of botany, or permission of the Department Chairman. This course may be repeated for credit. 1 cr.

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. *Prereq.:* Bot. 1 or Bot. 3. 2 lec.; 2 lab.; 4 cr. (Alternate years; offered in 1964-65.)

764. Microtechnique

Methods of embedding, sectioning, and staining plant tissues, and introduction to microscopy. Miss Nast. *Prereq.:* Bot. 1 or Bot. 3. 3 cr.

766. Morphology of Algae and Bryophytes

Form, life histories, and classification of the main divisions; identification and recognition of common species. Miss Nast. *Prereq.:* Bot. 1 or Bot. 3. 2 lec.; 2 lab.; 4 cr. (Alternate years; not offered in 1964-65.)

768. Mycology

The parasitic and saprophytic fungi, their growth, reproduction, and identification. Mr. Richards. Laboratory and assigned reading. 1 lec.; 2 lab.; 3 cr.

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 activities. The major contributions from Humboldt to the present time. Mr. Hodgdon. 3 cr. (Alternate years; offered in 1964-65.)

851. Advanced Plant Pathology

Advanced theories and methods in plant pathology. Mr. Rich. *Prereq.:* Bot. 51. Assigned reading, conferences and laboratory. 3 cr. (Alternate years; not offered in 1964-65.)

805. Advanced Plant Physiology

Plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, growth regulator effects. Mr. Dunn. *Prereq.:* Bot. 56 or equivalent, or adequate preparation in the physical sciences. Conferences, laboratory, and assigned reading. 4 cr. (Alternate years; not offered in 1964-65.)

895-896. Investigations in (a) Systematic Botany, (b) Plant Physiology, (c) Plant Pathology, (d) Plant Anatomy and Morphology, (e) Plant Ecology, (f) Mycology, and (g) Cytology

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

899 (899). M.S. Thesis 6-10 cr.

999 (999). Doctoral Dissertation

Chemical Engineering

Oswald T. Zimmerman, Chairman

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.

A candidate for the Master's degree in Chemical Engineering must complete a thesis, for which up to 6 credits will be allowed, and he must pass an oral examination covering his thesis and graduate courses.

613. Chemical Engineering Principles II

Transport phenomenon and stage operations. The equations of change as a basis for the study of molecular and turbulent transport of momentum, energy and mass, with emphasis upon the relation between the transport mechanism and the mathematical expression. Design principles and procedures for stagewise operations in various co-current and counter-current arrangements, based upon the ideal stage concept. Problems in both steady state and non-steady state operations. Mr. Lavine. 3 lec.; 1 lab.; 4 cr.

614. Chemical Engineering Principles III

Analysis of unit operations. Chemical engineering systems, with emphasis on the unit operations involved. Extension of previous studies of unit operations, and those not previously considered. Mr. Zimmerman. 3 lec.; 1 lab.; 4 cr.

617. Chemical Engineering Principles IV

Special methods of mathematical analysis, including transform methods, calculus of finite differences, and numerical techniques; and the use of analog and digital computors in the solution of chemical engineering problems. Mr. Fan. 3 lec.; 1 lab.; 4 cr.

622. Chemical Engineering Thermodynamics

General thermodynamic relationships and their application to power generation, refrigeration, and chemical processes; chemical equilibria and equilibrium in phase-change separations; introduction to statistical mechanics, and thermodynamics of irreversible processes. Mr. Chittenden. 3 cr.

631. Chemical Engineering Kinetics

Chemical kinetics, catalysis, and introduction to reactor design. Types of kinetic behavior in chemical processes; prediction of reaction rates in batch and flow reactors with and without catalysis; and application to reactor design. Mr. Fan. 3 lec.; 1 lab.; 4 cr.

641. Physical Metallurgy

The nature of metals, emphasizing the quantum mechanical description of the solid state 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. Mr. Zimmerman. 3 lec.; 1 lab.; 4 cr.

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. Mr. Lavine. 1 lec. or rec.; 3 lab.; 4 cr.

696. Chemical Engineering Project

Each student selects a research problem which he carries out independently under faculty supervision. Intensive study in both the library and the laboratory and a satisfactory report upon completion of the work are required. Staff. 3 lab.; 3 cr.

698. Independent Study

Projects in various areas as determined to be of particular interest and value to the student. Permission of the student's adviser and Department Chairman are required; and permission will be granted only to those students who have proved their ability by superior scholastic achievement. 2-4 cr.

752. Process Dynamics

Responses of physical systems and feedback principles and their application to design and analysis of process control systems. Mr. Zimmerman. 3 cr.

811. Chemical Engineering Calculations

Mathematical procedures, stressing application to the analysis of chemical engineering data and limitations of these procedures. Included are differential equations, statistics, series and numerical solutions, Laplace transforms, and the analysis of stagewise processes by the calculus of finite differences. Mr. Fan. 3 cr.

813. Transport Theory

Correlations of chemical engineering data from the point of view of their theoretical justification, and the mathematical treatment of transport phenomena applied to heat, mass, and momentum transport. Mr. Chittenden. 3 cr.

817. Unit Operations — Fluid Flow, Heat Flow, and Evaporation

An advanced course dealing with the fundamental theory and applications. Mr. Zimmerman. 2 cr.

818. Unit Operations — Diffusion Operations

An advanced study of the principles and their application to the unit operations of distillation, absorption, drying, humidification, and extraction. Mr. Zimmerman. 2 cr.

822. Chemical Engineering Thermodynamics

Recent developments in thermodynamics with emphasis on low temperature and high-pressure processes. Mr. Zimmerman. 3 cr.

831. Chemical Engineering Kinetics

Theory of reaction rates, batch and flow reactors, and catalytic reactions. Application of kinetics in industrial situations. Partial differential equations for heat and mass transfer in a reactor and their solutions for determining temperature and concentration distributions. Mr. Fan. 3 cr.

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. Mr. Fan. 3 cr.

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. Mr. Fan. 3 cr.

881. 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. Mr. Lavine. 3 cr.

883, 884. Unit Processes

Recent developments in pyrolysis, oxidation, chlorination, nitration, polymerization, and other unit processes. Mr. Lavine. 2 cr.

897, 898. Graduate Seminar

Discussions by staff and graduate students on recent developments. 1 cr.

899. Thesis — Problems in Chemical Engineering

Investigations in some phase of chemical engineering. Ch.E. staff. 1-6 cr.

Chemistry

Alexander R. Amell, *Chairman*

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.

Doctor of Philosophy Degree

Admission to the Ph.D. 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.

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 two original research proposals before his Doctoral Committee.

Master of Science Degree

Admission to the M.S. 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

The degree of Master of Science for Teachers 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. *Prereq.:* Chem. 683-684 or permission of the instructor. 3 cr.

804. Advanced Inorganic Chemistry

A survey from the modern point of view, with emphasis on theoretical and structural concepts. Mr. Haendler. *Prereq.:* Chem. 785, or its equivalent. 3 cr.

847. Advanced Inorganic Chemistry

The chemistry of coordination compounds, their structure, stereochemistry, and reactions. The metal-ligand bond. Mr. Haendler. *Prereq.:* Chem. 804. 3 cr.

848. Advanced Inorganic Chemistry

The theory and practice of x-ray diffraction and the determination of crystal structure. Mr. Haendler. *Prereq.:* Chem. 804. 3 cr.

Analytical Chemistry

661-662. Analytical Chemistry

The theory and techniques of gravimetric and volumetric analysis followed by special methods of analysis, such as those of ion exchange, chromatography, EDTA titrations and instrumental methods, including emission spectrography, flame spectrometry, spectrophotometry, gas chromatography,

coulometry, potentiometry, conductimetry, and polarography. Mr. Daggett. *Prereq.:* Chem. 405-406. 3 lec.; 2 lab.; 5 cr.

663. Introductory Radiochemical Techniques

Radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilizes radiochemical operations. *Prereq.:* general inorganic chemistry and general physics. Mr. Amell. 3 lec.; 2 lab.; 5 cr.

830. Advanced Instrumental Methods

Techniques of chemical analysis from the standpoint of both theory and application. Topics include NMR, ESR, X-ray fluorescence, mass spectrometry, and neutron activation analysis. *Prereq.:* Chem. 661. 3 cr.

831. Chemical Instrumentation

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

832. Advanced Chemical Analysis

This course is concerned with advanced methods of analysis as applied to simple and complex systems, inorganic, organic, and biological. 3 cr.

833. Chemical Separations

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

Organic Chemistry

755, 756. Structural and Theoretical Problems of Modern Organic Chemistry

The methods of preparation and reactions of the principal classes of organic compounds. The electron theory of organic chemistry is used to correlate these reactions. The variation in reactivity of these various classes of organic compounds is utilized as a method of characterization of organic compounds. Emphasis is on the solution of assigned problems. Mr. Lyle. *Prereq.:* One year of organic chemistry. First semester, 1 lec.; 2 lab.; 3 cr. Second semester, 3 lec.; 3 cr.

801. Theoretical Organic Chemistry

A qualitative introduction to chemical bonding, including valence bond and molecular orbital theories. Use of these theories in discussing aromaticity, conformational analysis, and the relationship of reactivity to ring size. 3 cr.

802. Theoretical Organic Chemistry

Stereochemistry, including optical isomerism, racemic modifications, determination of configuration, optical rotatory dispersion and its applications. Mechanistic concepts; theoretical and experimental methods used in the study of reaction mechanisms. 3 cr.

808, 809. Introduction to Research Techniques

Lectures and laboratory to show experimental methods and interpretation of results. Topics include spectroscopy, electrochemistry, separation methods, and others. Staff. 1-6 cr.

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. By permission of the instructor. 3 cr.

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. By permission of the instructor. 3 cr.

817, 818. Special Topics in Organic Chemistry

Specialized courses for the advanced student. Topics may include reaction mechanisms, stereochemistry, spectroscopy, molecular biochemistry, steroids, alkaloids, organic sulfur compounds, and nitrogen heterocycles. Mr. Kuivila, Mr. Lyle, Mr. Jones, Mrs. Lyle, and Mr. Anderson. 2 or 3 cr.

Physical Chemistry

683-684. Elementary Physical Chemistry

The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance and electromotive force. Mr. Wheeler. *Prereq.:* calculus, physics. 3 lec.; 2 lab.; 5 cr.

786. Advanced Physical Chemistry

A review of selected topics. Mr. Amell. *Prereq.:* One year of physical chemistry. 3 cr.

805, 806. Advanced Physical Chemistry

Wave mechanics and quantum chemistry, spectroscopy, molecular structure; second and third laws of thermodynamics, statistical thermodynamics, kinetics and mechanism. Mr. Pilar or Mr. Amell. *Prereq.:* One year of physical chemistry. 3 cr.

821. Physical Chemistry — Chemical Kinetics

The kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to photochemistry. Mr. Amell or Mr. Owens. *Prereq.:* One year of physical chemistry. 3 cr.

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. *Prereq.:* Chem. 805. 3 cr.

824. Advanced Physical Chemistry Laboratory

The more modern experimental technique with emphasis on the needs and interests of each individual student. Topics will include the measurement of refractive index, molecular rotation, activity coefficients by vapor pressure and E.M.F. methods, heterogeneous and homogeneous equilibrium constants, and kinetic constants. Mr. Wheeler. 1 lec.; 2 lab.; 3 cr.

826. Nuclear and Radiochemistry

Nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Appli-

cation of radiochemistry to chemical systems and research. Mr. Amell or Mr. Owens. 3 cr.

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 cr.

829. Theoretical Chemistry III

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

895, 896. Colloquium in Chemistry

a. Inorganic Chemistry, Mr. Haendler
b. Organic Chemistry, Mr. Anderson
c. Organic Chemistry, Mr. Lyle
d. Theoretical Organic Chemistry, Mr. Kuivila
e. Organic Chemistry, Mr. Iddles
f. Physical Chemistry, Mr. Amell
g. Physical Chemistry, Mr. Pilar
h. Physical Chemistry, Mr. Wheeler
i. Analytical and Physical Chemistry, Mr. Daggett
j. Organic Chemistry, Mr. Jones
k. Organic Chemistry, Mrs. Lyle
l. Analytical Chemistry, Mr. Ellis

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

897, 898. Seminar

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

899. Thesis — Problems in Chemistry

Conferences, library, and experimental work in some field of chemistry. Staff. Credits to be arranged.

999. Doctoral Research

Courses for the M.S.T. 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 cr.

782. Modern Inorganic Chemistry for the High School Teacher

The current concepts on such topics as fundamental particles, atomic structure, nuclear reactions, electronic configurations and orbitals, chemical bonds, the periodic table, oxidation-reduction, acids and bases, energy relationships, and ionic reactions. *Prereq.:* Freshman Chemistry. 4 cr.

783. Analytical Chemistry for High School Teachers

The principles of ionic equilibria in qualitative and quantitative analysis. Experimental work in qualitative analysis using the semimicro technique. The experimental work in quantitative analysis acquaints the student with

the principles, techniques, and calculations of gravimetric and volumetric determinations. Some experimental work involves the use of the spectrophotometer in quantitative analysis and the glass electrode method of measurement of pH. 8 cr.

784. Modern Approach to Organic Chemistry for High School Teachers

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

785. Physical Chemistry for High School Teachers

The laws of chemistry and their application to physical and chemical changes. *Prereq.:* College physics, algebra and trigonometry. 8 cr.

786. Radiochemistry for High School Teachers

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

787. Laboratory Techniques in Chemistry

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

788. Advanced Organic Chemistry for High School Teachers

Types of homolytic and heterolytic reactions of organic compounds and their relationship to organic structures, including configuration and conformation. *Prereq.:* Chem. 794 or its equivalent. 4 cr.

789. Atomic and Molecular Structure

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

Civil Engineering

J. Harold Zoller, *Chairman*

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 above 700 may be offered biennially or upon demand.

620. Transportation Engineering

The development, organization, administration, and inter-relation of transportation systems and facilities, including railroads, highways, airports, waterways, and pipe lines. The economics of location, geometric and structural design, construction materials, methods, and costs, as applied to modern transportation engineering. Mr. Skelton. *Prereq.:* C.E. 506. 3 cr.

642. Fluid Mechanics

Properties of fluids; fluid statics; flow of incompressible and compressible ideal fluids; flow of real fluids; and measurement of fluid properties. Mr. Dawson and Mr. Zoller. *Prereq.:* M.E. 527. 3 lec.; 1 lab.; 4 cr.

643. Water Supply and Treatment

The sources, quantity, quality, and sanitary aspects of public water supplies. Methods of purification and distribution systems. Mr. Langley. *Prereq.:* C.E. 642. 3 lec.; 1 lab.; 4 cr.

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. Mr. Langley. *Prereq.:* C.E. 643. 3 lec.; 1 lab.; 4 cr.

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. Mr. Skelton. *Prereq.:* C.E. 620 or permission of the instructor. 3 lec.; 1 lab.; 4 cr.

681. Theory of Structures I

The stress analysis of structures under fixed and moving loads. Roof trusses, highway and railroad bridges; use of influence lines, lateral bracing, and portals. Mr. Wang and Mr. Zoller. *Prereq.:* M.E. 527 as a prerequisite or concurrently. 3 lec.; 1 design period; 4 cr.

685. Theory of Structures II

Beam and truss deflections. The analysis of continuous beams and rigid frames by classical and modern methods; indeterminate trusses. Mr. Wang. *Prereq.:* C.E. 681. 3 lec.; 1 design period; 4 cr.

692. Steel Design

The design of members and connections; tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Mr. Wang. *Prereq.:* C.E. 517 and 681. 2 lec.; 1 design period; 3 cr.

693. Reinforced Concrete Design

The principles of reinforced concrete, including rectangular beams, slabs, T-beams, columns, footings, retaining walls. Mr. Wang. *Prereq.:* C.E. 685 as a prerequisite or concurrently. 2 lec.; 1 design period; 3 cr.

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. *Prereq.:* Permission of the instructor. 3 cr.

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. *Prereq.:* Permission of the instructor. 3 cr.

721. Highway Engineering I

Highway organization, administration, finance, planning, programming, traffic surveys, traffic methods; highway laws, contracts, specifications; highway capacity, geometric design, access control, safety, accident studies; pavement selection, performance, and maintenance. Mr. Skelton. *Prereq.:* C.E. 620. 3 cr.

722. Highway Engineering II

Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Mr. Skelton. *Prereq.:* C.E. 620. 3 lec.; 3 cr.

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. Mr. Langley and Mr. Zoller. *Prereq.:* C. E. 642. 2 lec.; 1 lab.; 3 cr.

742. Hydrology

The occurrence and physical effects of water on the earth, including meterology, groundwater, runoff, and streamflow routing. Mr. Langley and Mr. Zoller. *Prereq.:* C. E. 642 concurrently or as a prerequisite. 2 lec.; 1 lab.; 3 cr.

782. Timber Design

Properties and characteristics of structural woods, connection methods, design of timber members and connections in beams, columns, and trusses, and glued laminates of wood. Mr. Wang. *Prereq.:* C. E. 692 and permission of the instructor. 1 lec.; 1 design period; 2 cr.

784. Structural Components

Selected problems in the analysis and design of structural components, such as beams on elastic foundations, curved beams, beam columns, buckling, torsion. Introduction to the theory of elasticity. Mr. Wang. *Prereq.:* C. E. 692 and permission of the instructor. 3 lec.; 3 cr.

790. Structural Engineering

The planning and design of determinate and indeterminate structures. Introduction to modern design theories; prestressed concrete, plastic theory

of steel and reinforced concrete. Mr. Wang. *Prereq.:* C. E. 685 and C. E. 693. 2 lec.; 1 design period; 3 cr.

841-842. Advanced Hydraulics

Sediment transportation, secondary flows, design of hydraulic structures, reservoir and channel routing techniques, basic hydrodynamics and independent study. Mr. Zoller and Mr. Langley. *Prereq.:* Permission of the instructor. 3 cr.

843-844. Experimental Hydraulics

Experimental techniques and laboratory practice. Experimental studies of the fundamental phenomena of liquid flow. Mr. Dawson. *Prereq.:* C. E. 642 and permission of the instructor. 3 cr.

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. Mr. Zoller and Mr. Langley. *Prereq.:* C. E. 643 and 644 and permission of the instructor. 3 cr.

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. Mr. Skelton. *Prereq.:* C. E. 665 and permission of the instructor. 3 cr.

865. Soil Testing for Engineering Purposes

The essential tests for the physical properties: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. Mr. Skelton. *Prereq.:* Permission of the instructor. 2 to 4 cr.

866. Foundation Engineering

Application of the principles of soil mechanics to selection of type of substructure, foundation construction methods, exploratory soil studies, stability analysis, earth dam and tunnel construction, and underpinning operations. Mr. Skelton. *Prereq.:* C. E. 665 and permission of the instructor. 3 cr.

881-882. Advanced Structural Analysis

Comprehensive consideration of the methods of structural analysis and their application to the design of two and three-dimensional structures. Mr. Wang. *Prereq.:* C. E. 790 and permission of the instructor. 3 cr.

883. Advanced Structural Design

Ultimate strength design in reinforced concrete. Prestressed concrete design. Plastic design of steel structures. Mr. Wang. *Prereq.:* C. E. 685 and permission of the instructor. 3 cr.

895, 896. Civil Engineering Problems

The study and investigations of problems selected to meet the needs of the student. *Prereq.:* Permission of the instructor. 2 or 3 cr.

899. Master's Thesis

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

Dairy Science

(See Animal Sciences)

Economics

Robert F. Barlow, *Dean*

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. 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;
   (b) a maximum of 9 semester hours in approved courses numbered 600 and above *in related disciplines.*
2. Evidence of proficiency in economic analysis, inclusive of both price and income analysis.
3. Evidence of proficiency in any two of the following four fields: economic history, history of economic thought, mathematical economics, and statistics, as well as two additional fields chosen from among the following: international economics, monetary and fiscal policy, industrial organization, labor economics and industrial relations, agricultural economics, and economic development and comparative economic systems. The thesis area will be considered as one field.
4. Students electing the non-thesis option will be required to take both oral and written comprehensive examinations.

Students electing the thesis option will be required to take an oral examination.

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.

652. Public Finance

Problems and policies of expenditure, revenue and debt of federal, state, and local governments. Economic analysis and evaluation of individual types of taxes and general fiscal programs of government. Fiscal problems in the State of New Hampshire. Mr. Rothwell. 3 cr.

653. Money and Banking

The monetary and banking system with reference to monetary standards, value of money, commercial and non-commercial banking, and the structure and policy of the Federal Reserve System. Mr. Degler. 3 cr.

657. Government Regulation of Business

The role of government in economic affairs, with emphasis upon the regulation of competition and monopoly. Mr. Irwin. 3 cr.

663. International Trade and Finance

Theory of international trade, foreign exchange, balance of payments, tariffs, and protection. The economic aspects of international relations, with particular reference to recent policies. Miss Woodruff. 3 cr.

664. Comparative Economic Systems

An examination of socialism, communism, capitalism, and modifications of these economic systems, particularly as exemplified by the Soviet Union, China, Yugoslavia, India, the United Kingdom, and the United States. Mr. Barlow. 3 cr.

666. Economic Development

An analysis of the problems and available solutions confronting the underdeveloped areas of the world. Mr. Rothwell. 3 cr.

671. Trade Unions and Industrial Management

Trade union history, philosophy, and policies. Historical development of management attitudes and the attitudes of law and legislation toward unions. Collective bargaining: its nature, purpose, and public policy considerations. Mr. Hogan. 3 cr.

672. Labor Economics

Application of the tools of economic analysis to the market for labor. Wage determination and wage policy under union and non-union conditions. The determination of factor shares of the national income with particular emphasis on labor's share. Mr. Hogan. 3 cr.

673. Intermediate Economic Analysis

Analysis of supply and demand. The determination of prices, production, and the distribution of income in non-competitive situations as well as in the purely competitive model. General equilibrium. Mr. Bergeron. 3 cr.

675. National Income Analysis

Macro-economic measurement, theory, and public determination. Mr. Rosen. 3 cr.

679-680. History of Economic Thought

The evolution of economic thought, including the work of contemporary economists. 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. Irwin. 3 cr.

704. Economic History

An analysis of the development of the American and European economies. Miss Woodruff. 3 cr.

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 cr.

758. 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 cr.

761. Economic Systems

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

763. International Economics

A survey of 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 cr.

773. Advanced National Income Analysis

Emphasis on national income theory, its development, and policy implications. Mr. Rosen. 3 cr.

774. Mathematical Economics

Application of mathematical techniques to selected problems in economic analysis. Mr. Bergeron. 3 cr.

776. Economic Fluctuations

The recurrent movements of prosperity and depression, with emphasis upon causes and public policy implications. Mr. Rosen. 3 cr.

778. Advanced Economic Analysis

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

797. Seminar in Economic Development

A survey of theories and detailed case studies in problems of economic development. Mr. Rothwell. 3 cr.

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 cr.

852. Collective Bargaining

The problems involved in arriving at and administering labor-management agreements. Analysis of problems and issues, such as the recognition clause, union security, management security, seniority, grievances and arbitration, wages, work assignments, technological change, automation, and others. Mr. Hogan. 3 cr.

857-858. History of Economic Thought

The evolution of economic thought, including the work of contemporary economists. 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. Irwin. 3 cr.

895-896. Independent Study

Selected projects. Staff. 6 cr.

898. Seminar in Monetary and Fiscal Policy

An analysis of policy alternatives, with emphasis on the evaluation of contemporary policy measures. Mr. Rosen. 3 cr.

899. Thesis

Staff. 6 cr.

Education

Roland B. Kimball, *Chairman*

For admission to graduate study in Education, a student must present, in addition to a Bachelor's degree, evidence of having satisfactorily completed the following requirements: For Curriculum I and Curriculum IV, either an undergraduate major in Elementary Education or (a) a year of educational psychology or its equivalent, and (b) major subject preparation comparable to University of New Hampshire undergraduate requirements.

For Curriculum II, a student must be fully certified as a teacher or give other evidence of undergraduate preparation in psychology and the principles of education and have the personal qualifications necessary for counseling. Courses in human development and mental hygiene must be included.

Curriculum III is a program for teachers of the deaf operated in affiliation with the Crotched Mountain Foundation School for the Deaf. Students interested in entering this program will be expected to make their first contact with the Crotched Mountain Foundation School for the Deaf, Greenfield, N. H. The staff there will make a judgment as to the individual's suitability for teaching in this special field. If the candidate seems to have the personal qualifications for teaching the deaf, he then will apply to the Graduate School for admission. This application will be acted upon by the Department of Education and the Dean of

the Graduate School. The candidate will be required to meet in full the usual standards of admission for graduate study at the University. In addition, students entering this program must meet certification requirements for teaching, preferably at the elementary level, and in addition to the usual work in psychology included in teacher-education programs, should have a course in either abnormal psychology or mental hygiene. Also included in their training must be a course in teaching the language arts. The candidate must offer student-teaching and observation in public schools with normal children or at least one year of successful classroom teaching experience with normal children.

For the degree of Master of Education, 30 credits must be earned in Curricula I and II and 36 credits in Curricula III and Curricula IV. Areas in which competence must be demonstrated, and courses suggested to aid in acquiring this competence, are listed in Curriculum I, unless the student is preparing for guidance counseling in which case Curriculum II is the guide.

Curriculum I

Principles of education — Ed. 759.

General methods and curriculum — Ed. 758 or 858 or Ed. 745.

Special methods — Ed. 791 or 792 or Ed. 731 and 738.

Teaching experience — Ed. 794 or successful teaching experience.

Dynamics of behavior — Psych. 605 or Psych. 841.

Advanced educational psychology — Ed. 883.

Measurement — Ed. 885.

Philosophy of education — Ed. 886.

Curriculum II

This program, for the preparation of school guidance counselors, represents a cooperative effort on the parts of the departments of Education and Psychology. The degree earned will be Master of Education.

In the usual program of studies in this curriculum, students take the following courses:

Psych. 654 Psychopathology
Psych. 663 Differential Psychology
Psych. 808 Case Studies in Counselling
Psych. 823 Individual Testing
Ed. 871 Principles of Guidance
Ed. 872 Techniques of School Counselling
Ed. 873 Occupational Information

Ed. 874 Administration of Guidance
Ed. 875 Practicum in Counselling
Ed. 885 Tests and Measurement

When the student's objective warrants, Psych. 808, Psych. 823, and Ed. 873 may be waived in individual cases.

Other recommended courses in this curriculum, which are suggested as electives, follow:

Psych. 841 Personality Theory
Ed. 853 Curriculum Seminar
Ed. 883 Advanced Educational Psychology
Ed. 886 Philosophy of Education

The usual program of studies will prepare an individual for a career as a school guidance counselor. It also will serve as the first year of graduate study for a person desiring to become a school psychologist. To meet the needs of persons with differing objectives, some flexibility has been incorporated in the program.

Curriculum III

This program is designed for teachers of the deaf and is operated by the University of New Hampshire in affiliation with the Crotched Mountain Foundation School for the Deaf. The following courses must be completed for the Master of Education degree.

Academic Year
Teacher Training at Crotched Mountain
Ed. 830 Psychology and Education of Exceptional Children
Ed. 825 Audiology
Ed. 815 History, Education, and Guidance of the Deaf
Ed. 818 Anatomy and Physiology of the Auditory and Vocal Mechanisms
Ed. 819 Speech Reading to the Deaf
Ed. 816 Language to the Deaf, Part I
Ed. 817 Language to the Deaf, Part II
Ed. 827 Elementary School Subjects to the Deaf
Ed. 820 Speech to the Deaf
Ed. 826 Observation and Student Teaching
Ed. 828 Advanced Audiology
Ed. 829 Selection and Use of Hearing Aids
Summer Session
Psych. 605 Mental Hygiene for Teachers
Ed. 883 Advanced Educational Psychology
Ed. 886 Educational Philosophy
(May be taken second semester of academic year.)

Curriculum IV

This is a program for a Master of Education degree for school librarians. Students who meet the general requirements for admission to the Graduate School may take courses leading to a

Master's degree in Education with a major in School Library Education.

Students planning to receive the Master of Education degree with a major in School Library Education must complete 36 semester hours in the field of education and library science.

The following courses are required:

Ed. 734 Children's Literature
Ed. 842 Library Organization and Service
Ed. 843 Basic Reference and Informational Services for the School Library
Ed. 844-845 Technical Processes in the School Library
Ed. 846 Selection and Acquisition of Books and Other Materials
Ed. 847 Reading Guidance
Ed. 848 Directed Research in School Librarianship

Other recommended courses:

Psych. 605 Mental Hygiene for Teachers
Ed. 883 Advanced Educational Psychology
Ed. 886 Educational Philosophy

Students who meet the requirements of their curriculum are free to select, subject to the approval of an adviser, the remainder of their work from Education and subject-matter courses arranged to secure most effective preparation for the professional work they desire to pursue.

Comprehensive Oral Examination

Near the end of 30 semester hours of work the candidate for the Master's degree in Education in Curricula I or II begins writing, with the help of the Chairman of the Master of Education Degree Committee, a group of statements which are his own stand on basic issues in education. The aim of the writing of these statements is to help the candidate pull together the ideas and points of view he has taken from course work and his previous experience into his own working philosophy of education. When he finishes his courses and the writing of the complete set of statements, he defends these statements in an oral examination.

The date of the oral examination shall not precede the date of completion of all courses in the candidate's program. Under normal circumstances, completion of the degree program will require 12 months of full-time graduate study and, in addition, completion of the oral examination. It is not realistic for candidates to plan to complete *all* requirements for the Master's degree in Education in one academic year. If the oral examination is to be taken during the academic year, completed theses must be submitted on or before April 20; if the examination is scheduled for the summer, July 20 is the last date for submitting the

completed theses. No more than two opportunities are permitted for the submission of the complete sets of statements to the Master of Education Degree Committee, and no more than two opportunities are permitted for the oral examination. Students in Curriculum III and Curriculum IV are not required to write theses or take the oral examination.

755. An Educational Psychology of Development

The relation of factors of growth, learning, intelligence, individual differences, and personality to more effective learning. Emphasizes child development. 3 cr. (Formerly 55)

757. Principles of Learning

Psychology of learning as it operates within the classroom. *Prereq.:* Ed. 481 or 755 and permission of the department. 3 cr. (Formerly 57)

758. Principles of Teaching

Application of the theories of learning studied in Educ. 757, with emphasis upon the following: organization of content, specific planning, and a study of procedures essential to the evaluation of the learning processes. *Prereq.:* Ed. 757 and permission of department. Two 2-hour rec.-labs.; 3 cr. (Formerly 58)

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. 3 cr. (Formerly 59)

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. Mr. Bardwell. *Prereq.:* Ed. 757 or permission of instructor. 3 cr. (Formerly 63)

785. Utilization of Testing in Public Education

Strategies for discovering and employing predictive validities of standardized tests in public school work. Mr. Lohnes. 3 cr. (Formerly 64)

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. Adaptation of various methods and plans as carried on in modern elementary schools. Miss Stone. 3 cr. (Formerly 95)

815. History, Education, and Guidance of the Deaf

An evaluation of the place of the deaf in the community from social, economic, and political viewpoints from ancient times to present. Bibliographic source materials in the field on education and welfare. Studies related to the psychology, social adjustment and the learning problems of the

deaf. Given at Crotched Mountain. *Prereq.:* History or philosophy of education. 2 cr. (Formerly 169)

816-817. The Teaching of Language to the Deaf. I, II

The principles and techniques of teaching language to the pre-school and school-age deaf child. The leading systems of teaching language to the deaf. Emphasis on natural language for the deaf and the Fitzgerald Key. Given at Crotched Mountain. *Prereq.:* Ed. 733 or permission of the instructor. 2 cr. (Formerly 170-171)

818. Anatomy and Physiology of the Auditory and Vocal Mechanisms

The anatomy, physiology, and pathology of the speech and hearing mechanisms. Given at Crotched Mountain. 2 cr. (Formerly 172)

819. Methods of Teaching Speechreading to the Deaf and Hard of Hearing

The various principles and techniques of teaching speechreading, Nitchie, Jena, Kinzie, Muller-Walle, etc., and research pertaining to lipreading. Given at Crotched Mountain. 2 cr. (Formerly 173)

820. The Teaching of Speech to the Deaf

The principles and techniques used in developing the formation of English sounds by the analytical method and also the introduction of speech by the whole-word method. Correction of speech defects in the hard of hearing. Development of speech in the pre-school and school-age deaf child. Given at Crotched Mountain. 2 cr. (Formerly 174)

825. Audiology

Hearing tests and auditory training. The techniques and interpretation of pure tone hearing tests and an introduction to speech audiometry. Audiogram interpretation. Air and bone conduction tests on children of varying ages who are in schools for classes for the deaf. Introduction to several types of amplification systems used in school and classes for the deaf. Techniques and principles of auditory training programs. Given at Crotched Mountain. *Prereq.:* Ed. 818. 3 cr. (Formerly 175)

826. Observation, Student Teaching, and other Laboratory Activities

Students travel widely to observe several schools having differing philosophies of education. Given at Crotched Mountain. 3 cr. (Formerly 177)

827. Methods of Teaching Elementary School Subjects to the Deaf

An understanding of what language deprivation means in developing elementary curriculum for the deaf child. Principles and methods of teaching reading in the lower and higher grades. Methods of teaching subjects such as arithmetic, social studies, and sciences and health. Methodology in the intermediate and advanced grades. Consideration and use of visual aids. *Prereq.:* Methods in teaching elementary subjects, especially arithmetic, science, social studies, and reading or major in elementary or secondary education. Given at Crotched Mountain. 2 cr. (Formerly 178)

828. Advanced Audiology

Advanced puretone speech auditometry. Special tests and exploratory techniques in audiometry, logical assessment, instrumentation and testing rooms. Industrial audiology and conduct of an audiological clinic. Given at Crotched Mountain. *Prereq.:* Ed. 825. 3 cr. (Formerly 179)

829. Selection and Use of Hearing Aids

Research and theory of clinical selection of hearing aids. Given at Crotched Mountain. *Prereq.:* Ed. 818 and 825. 3 cr. (Formerly 180)

830. Psychology and Education of Exceptional Children

A survey of all fields of special education. Psychological problems arising from handicapping conditions. Given at Crotched Mountain. 2 cr. (Formerly 181)

Special Methods in Secondary School Teaching

The curricula and methods in the various secondary school subjects. Emphasis will be on observation and planning. There will be a different course for each major subject area:

831. Art
832. Biology
833. English
834. General science
835. Foreign language
836. Mathematics
837. Physical science
838. Social studies
839. Music

Prereq.: Ed. 757 and 758 or 858. May be taken concurrently. Preparation in subject-matter field equivalent to a college major. 3 cr. (Formerly 99)

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 cr. (Formerly 184)

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 cr. (Formerly 185)

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 cr. (Formerly 186-187)

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. 3 cr. (Formerly 188)

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, read-

ing disabilities, and other factors that retard or promote the use of printed materials. 3 cr. (Formerly 189).

848. Directed Research in School Librarianship

2-4 credits (Formerly 190)

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. *Prereq.:* Permission of the instructor. 3 cr.

851. Programmed Instruction

Examination of the advantages and limitations of programmed instruction and of its psychological foundation. The various types of teaching machines, the results of experimentation with programmed instruction, and the method of developing programmed instruction material. Mr. Bardwell. 3 cr. (Formerly 162)

852. Principles and Problems of Secondary-School Curriculum Reorganization

Significant changes in secondary-school offerings, with emphasis on curriculum revision and techniques of revision. Mr. Koch. 3 cr. (Formerly 113)

853. Seminar in Curriculum Study

The techniques and procedures of curriculum development for the purpose of better meeting the educational needs of adolescents. Mr. Koch. 3 cr. (Formerly 114)

858. Advanced Study in Planning for Teaching in High School

An opportunity to study problems, principles, and teachings which are involved in planning for pupil learning. *Prereq.:* For graduate students with teaching experience. 3 cr. (Formerly 160)

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. 3 cr. (Formerly 102)

862. Educational Finance and Business Management

Aspects and principles of financing education, budgetary procedure, accounting, auditing, school indebtedness, financial reporting and business management. Experience in handling practical school finance problems will be part of the project work. *Prereq.:* A basic administration course or equivalent in experience. 3 cr. (Formerly 125)

863-864. Seminar in Educational Administration

The study of cases and concepts. *Prereq.:* A basic administration course. 3 cr. (Formerly 133, 134)

865. Problems in the Supervision of Teaching

Problems of human relations in curriculum development. Field research or library research is required. Designed for principals, superintendents, and the supervisors of cadet teachers. 3 cr. (Formerly 122)

871. Principles of Guidance

A first course which tries to help the student understand and utilize the philosophies and processes of guidance as they operate in his own behavior. Mr. Menge. *Prereq.:* Educational Psychology. 3 cr. (Formerly 111)

872. Techniques of School Counseling

Methods of counseling school pupils. *Prereq.:* Ed. 871. 3 cr. (Formerly 119)

873. Informational Materials in Guidance

A broad perspective of guidance materials, including follow-up studies, community surveys, and the *Dictionary of Occupational Titles.* Designed for teachers or prospective counselors working toward certification in guidance. *Prereq.:* Ed. 871 or permission of the instructor. (Formerly 117)

874. Organization and Administration of Guidance

An advanced course for teacher-counselors, counselors, and administrators who are interested in planning or reorganizing a guidance program. It will be conducted as a seminar, giving practice in group dynamics. *Prereq.:* Ed. 871, 873, 885 or permission of the instructor. 3 cr. (Formerly 118)

875. Practicum in Counseling

Vocational and educational counseling of adolescents under supervision. *Prereq.:* Ed. 873, 885 and permission of the instructor. 1-4 cr. (Formerly 120)

881-882. Research Problems in Education

Prereq.: Permission of instructor. 2 to 6 cr. (Formerly 131-132)

883. Advanced Educational Psychology

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. Mr. Koch. *Prereq.:* Ed. 757. 3 cr. (Formerly 150)

884. Education in Foreign Countries

Educational developments in selected foreign countries are examined in relation to the cultural background and present-day needs of the people. The sociological and psychological factors that influence the educational policy and the structure of each national school system. 3 cr. *(Offered in Extension and Summer Session only.)* (Formerly 54)

885. Educational Tests and Measurements

Testing theory and practice concerned with a two-fold analysis of standardized tests and batteries in terms of (a) their psychological, or factorial, meanings, and (b) their practical, or predictive uses. 3 cr. (Formerly 165)

886. Philosophy of Education

Current educational objectives and practices and the philosophical foundations upon which they are based. Mr. Marshall. 3 cr. (Formerly 176)

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 cr. *(Offered in Extension and Summer Session only.)* (Formerly 53)

895, 896. Seminar in Contemporary Educational Issues and Practices Section 1: Workshop in Team Teaching

A detailed analysis of selected contemporary educational issues and practices. Consideration will be given to experimental projects that have explored the rationale, operational requirements, and effectiveness of these practices. 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. (Educ. 895, Section 1 offered Summer, 1964. 6 cr. *Prereq.:* Teaching experience. 3-6 cr.

Courses in Problems in Teaching High-School Subjects

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, Educ. 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 (Ag-Ed) 650. Principles of Agricultural Education. Mr. Annis. 3 cr. (Formerly 88)

Agriculture-Education (Ag-Ed) 651, 652. Methods of Teaching Agricultural Mechanics

Mr. Gilman. 1 cr. (Formerly 89, 90)

Agriculture-Education (Ag-Ed) (792). Planning for Teaching

Mr. Annis. 4 cr. (Formerly 91)

Art-Education (Art-Ed) 792. Problems of Teaching Art in Elementary Schools

Mr. Thomas. 3 cr. (Formerly 91)

Art-Education (Art-Ed) 791. Problems of Teaching Art in Secondary Schools

Mr. Thomas. 3 cr. (Formerly 92)

Biology-Education (Bi-Ed) 791. Problems in the Teaching of High-School Biology

Mr. Schaefer. 3 cr. (Formerly 91)

English-Education (Eng-Ed) 791. Problems in the Teaching of High-School English

Mr. Goffe. 3 cr. (Formerly 91)

History-Education (Hist-Ed) 791. Problems in the Teaching of High-School History and Other Social Studies

3 cr. (Formerly 91)

Home Economics-Education (HE-Ed) 791. Problems in the Teaching of High-School Home Economics

3 cr. (Formerly 91)

Language-Education (Lang-Ed) 791. Problems in the Teaching of Foreign Languages in the High School

Mr. Chasse. 3 cr. (Formerly 91)

Mathematics-Education (Math-Ed) 791. Problems in the Teaching of High-School Mathematics

Mr. Balomenos. 3 cr. (Formerly 91)

Music-Education (Mus-Ed) 791. Problems in the Teaching of Secondary School Music

Mr. Whitlock. 3 cr. (Formerly 92)

Music-Education (Mus-Ed) 792. Problems in the Teaching of Elementary School Music

Mr. Whitlock. 3 cr. (Formerly 91)

Physical Education (PE-Ed) 791. Problems in the Teaching of Physical Education for Women

Miss Newman. 3 cr. (Formerly 91)

Courses in Supervised Teaching

Supervised teaching is not open to a graduate of another institution unless he first completes an approved program of teacher preparation in the University.

Applications for supervised teaching must be filed in the office of the Department of Education at least four weeks before the date at which supervised teaching begins. These applications must be approved by the Chairman of the Department of Education and the Coordinator of Supervised Teaching. An applicant must complete Educ. 758 or 858, and must have a sufficient background in a subject-matter field in which he is planning to teach. He must also complete a course in the problems of teaching in his major field. Supervised teaching, as administered by the Department of Education, is usually a full-time job off campus for one semester.

Students may be enrolled for from 6 to 14 credits of work in supervised teaching. Students may count no more than 9 semester credits in supervised teaching toward the Master of Education degree.

Education-Agriculture (Ed-Ag) (794). Supervised Teaching in Agriculture

Prereq.: Senior standing in Ag-Ed Curriculum. (Formerly 93)

Education-Art (Ed-Art) 794. Supervised Teaching in Secondary School Art

Prereq.: Art-Ed 791. (Formerly 94)

Education-Biology (Ed-Bi) 794. Supervised Teaching in High-School Biology

Prereq.: Bi-Ed 791. (Formerly 94)

Education-Commerce (Ed-Co) 794. Supervised Teaching in High-School Commercial Subjects

(Formerly 94)

Education-English (Ed-Eng) 794. Supervised Teaching in High-School English

Prereq.: Eng-Ed 791. (Formerly 94)

Education-History (Ed-Hist) 794. Supervised Teaching in High-School History

Prereq.: Hist-Ed 791. (Formerly 94)

Education-Home Economics (Ed-HE) 794. Supervised Teaching in High-School Home Economics

Prereq.: HE-Ed 791. (Formerly 94)

Education-Language (Ed-Lang) 794. Supervised Teaching in High-School French

Prereq.: Lang-Ed 791. (Formerly 94)

Education-Latin (Ed-Lat) 794. Supervised Teaching in High-School Latin

(Formerly 94)

Education-Mathematics (Ed-Math) 794. Supervised Teaching in High-School Mathemtics

Prereq.: Math-Ed 791. (Formerly 94)

Education-Music (Ed-Mus) 793. Supervised Teaching in Elementary School Music

(Formerly 93)

Education-Music (Ed-Mus) 794. Supervised Teaching in High School Music

(Formerly 94)

Education-Physical Education (Ed-PE) (794), 794. Directed Teaching of Physical Education for Women

Prereq.: PE-Ed 791 or concurrently. 1 lec. or rec.; 2 2-hr. labs.; 3-6 cr. (Formerly 92)

Education-Physical Education (Ed-PE) 793, (793). Directed Teaching in Physical Education for Men. (Formerly 93)

Elementary Education

Except for Ed. 741-742, courses in Elementary Education are given only during the Summer Session and in Extension.

731. Workshop in Reading

An understanding of the methods and materials of instruction in reading. Skills, techniques, and attitudes necessary to insure in children a permanent love of, and an interest in reading will be demonstrated in the classroom and analyzed in discussion groups. The relationship of reading to the other language arts in the elementary schools. Should be taken concurrently with Ed. 738 and Ed. 787. 3 cr. (Formerly 73)

733. The Teaching of Language Arts in Elementary Schools

The guidance of learning activities in the development of languages. An exploration of ways which help children grow in control of speaking, writing, and reading. 3 cr. (Formerly 76)

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 cr. (Formerly 77)

735. The Teaching of Elementary School Foreign Languages

Methods and materials for the audio-lingual teaching of foreign languages in the elementary school. 3 cr. (Formerly 79)

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 cr. (Formerly 82)

737. New Concepts in the Teaching of Arithmetic

Formation of number concepts and the development of arithmetic skills. Modern methods of teaching arithmetic are demonstrated. *Prereq.:* Teaching experience. 3 cr. (Formerly 84)

738. Workshop in Arithmetic

Designed for pre-service teachers. Combines theory and classroom demonstrations of contemporary methods of instruction in arithmetic. *Prereq.:* Should be taken concurrently with Ed. 731 and Ed. 787. 3 cr. (Formerly 85)

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 cr. (Formerly 86)

741-742. Elementary School Teacher Preparation

A block program including observation; psychology of learning, principles of teaching reading, language arts, social studies, mathematics, science, and other elementary school subjects; practice teaching; and a synthesizing seminar. 16 cr. each semester. (Formerly 71-72)

745. Elementary School Curriculum Reorganization

The theories and procedures of curriculum development in the elementary school. 3 cr. (Formerly 89)

753. Teaching Exceptional Children

A consideration of the organization, materials, and methods suitable for the instruction of a-typical children. Emphasis will be given to the teach-

ing of creative children. Use of prose, poetry, creative dramatics, and similar teaching techniques. 3 cr. (Formerly 74)

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 various methods and plans as carried on in modern elementary schools. 3 cr. (Formerly 95)

807. The Improvement of Reading
Designed especially to help teachers diagnose and correct reading difficulties. Materials, methods, and procedures in reading for corrective work on both a group and individual basis. The emphasis is of a practical nature. It will aid the teaching of reading to all children as well as to children who experience difficulties. 3 cr. (Formerly 75)

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 working with individuals, teams, small groups, and classes. *Prereq.:* Ed. 732. 3 cr.

809. Reading Clinic
Practicum in improvement of reading including direct experiences with children having reading difficulties. Seminars will consider individual cases and remedial procedures. *Prereq.:* Ed. 842 (may be taken concurrently). (Formerly 78)

Electrical Engineering

Alden L. Winn, *Chairman*
John B. Hraba, *Graduate Adviser*

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.

All students will be required to complete two basic courses, E.E. 801, Field Theory, and E.E. 811, Network Analysis, at the beginning of their graduate program or furnish evidence of equivalent preparation. These two courses and those numbered below 800 are normally offered annually. Other courses numbered above 800 are offered on the basis of the requirements of the graduate students. Those who intend to undertake graduate work in Electrical Engineering must consult with the department graduate adviser in order to plan their programs of study. With the consent of the department a student, who through industrial experience has satisfied the objectives of a thesis may be permitted to substitute approved course work for the thesis requirement.

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

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

609. Physical Electronics

Electron ballistics; conduction in gases, vacuum, metals, and semiconductors; theory of emission; theory of operation, characteristic curves, and equivalent circuits for electron devices such as vacuum and gas tubes, solid-state rectifiers, and transistors. *Prereq.:* E.E. 515 concurrently or equivalent. 3 cr.

640. Circuits, Machinery, and Control

Continuation of electric circuits. Applications of electrical engineering to machines and systems. *Prereq.:* E.E. 533 or 539. 3 lec.; 1 lab.; 4 cr.

641. Electronic Fundamentals

Physical electronics; electronic circuits with emphasis on instrumentation. *Prereq.:* E.E. 533 or 539. 2 lec.; 1 lab.; 3 cr.

645. Electrical Networks

Generalized network analysis, equivalent networks, filter properties, elementary synthesis, transient and steady-state analysis of transmission lines. *Prereq.:* E.E. 515. 3 cr.

646. Electric Fields

Static electric and magnetic fields, electromagnetic fields, Maxwell's equations, wave equations, plane waves. *Prereq.:* E.E. 502, Math. 541. 3 cr.

652. Industrial Electronics Fundamentals

Application of electronics to industrial processes. *Prereq.:* E.E. 641 or equivalent. 2 rec. and 1 lab.; 3 cr.

696. Electrical Engineering Projects

A laboratory or independent study course. Each student will either join one of the department research projects or engage in a project which is in one of the areas of current staff interest. Admission to the course will be limited to those accepted by a staff member. 1-4 conferences or 1-2 laboratories; 1-4 cr.

706. Advanced Circuit Theory

Steady-state and transient analysis, derivation of fundamental formulas and constants, application of LaPlace transforms. Mr. Nulsen. 3 rec.; 1 conf.; 4 cr.

757. Electronic Systems Analysis and Design

Advanced techniques in network and systems analysis; use of complex frequency and signal flow graphs; coding, transfer, and storage of information. 3 rec.; 1 conf.; 4 cr.

762. Illumination

Radiation, fundamental processes in gases, atomic spectra, sources of visible and near visible energy, lamp circuitry, lighting and wiring design, control of light, photometry, and color. Mr. Murdoch. 2 cr.

780. Engineering Analysis

The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. E.E. Staff. 2 cr.

781. Instrumentation

Analysis and design of equipment for measurement, instrumentation, and control. Mr. Blanchard. 3 rec.; 1 lab.; 4 cr.

782. Control Systems

Fundamental principles involved in the design and analysis of feedback control systems. Mr. Blanchard. 3 rec. and 1 lab.; 4 cr.

801. Field Theory

The development of Maxwell's Equation; application of vector calculus, boundary values, and conformal mapping to static field problems; and an introductory treatment of the general wave equation. Mr. Hraba. 4 cr.

802. Electromagnetic Wave Theory

Solution of the wave equation in rectangular, cylindrical, and spherical coordinates; reflection and refraction; wave guides and cavities; wave propagation in specialized media; sources; and antenna pattern formations and characteristics. Mr. Clark. *Prereq.:* E.E. 801. 4 cr.

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. *Prereq.:* E.E. 802. Mr. Frost. 3 rec. and 1 lab. or conf.; 4 cr.

804. Antennas

Theory and design of electromagnetic radiating systems. Mr. Frost. *Prereq.:* E.E. 802. 3 rec. and 1 lab. or conf.; 4 cr.

811. Network Analysis

The application of matrices and determinants, linear graph theory, Laplace and Fourier transforms, complex-variable theory and time- and frequency-domain concepts to the analysis of linear networks and systems. Mr. Murdoch. 4 cr.

812. Network Synthesis

Characteristics of one-to n-port network functions, realizability criteria and synthesis of one-, two- and three- element-kind driving-point and transfer functions. Mr. Murdoch. *Prereq.:* E.E. 811. 4 cr.

813. Nonlinear Networks

Analysis of passive networks with non-linear and time-varying parameters. Mr. Hraba. 3 rec. and 1 conf.; 4 cr.

814. Network Approximation

Network functions and topologies, dynamic and geometric independence, equivalent networks and the approximation problem in the time and frequency domains. Mr. Murdoch. *Prereq.:* E.E. 812. 4 cr.

815. Linear Active Circuits

The development of equivalent circuits for solid-state devices; and the analysis and design of linear networks containing these devices. Mr. Winn. 3 rec. and 1 lab. or conf.; 4 cr.

816. Nonlinear Active Circuits

Analytical and graphical techniques for circuits designed for pulse and other non-sinusoidal signals; and solid-state or vaccum-tube devices used in the switching mode. Mr. Winn. 3 rec. and 1 lab. or conf.; 4 cr.

819. Nonlinear Magnetic Devices

Magnetic amplifiers with and without feedback, magnetic devices as modulators, frequency multipliers, and in switching circuits, modern theory of magnetism, properties of square-loop magnetic material. Mr. Melvin. 4 cr.

821. Transmission and Distribution of Electric Power

Line characteristics, steady-state performance, symmetrical components, lightning and over-current protection, relaying. Mr. Goodrich. 3 rec. and 1 lab. or conf.; 4 cr.

825. Advanced Analysis of Alternating-Current Machinery

Steady-state and transient analysis of all alternating- and direct-current machines. Mr. Hraba. 3 rec. and 1 lab. or conf.; 4 cr.

840. Information Theory

Introduction to statistical methods, noise sources; noise in linear systems, information transmission, methods of modulation. Mr. Clark. 4 cr.

841. Applied Acoustics

The propagation of acoustical waves in elastic media, characteristics of electro-acoustical transducers, architectural acoustics. Mr. Frost. 3 rec. and 1 lab. or conf.; 4 cr.

851. Principles of Feedback Control

Analysis and design of linear and nonlinear feedback control systems. Mr. Blanchard. *Prerq.:* E.E. 782 or equivalent. 3 rec. and 1 lab. or conf.; 4 cr.

898. Electrical Engineering Projects

Independent studies in a specialized field of electrical engineering. E.E. Staff. Admission to the course will be limited to those accepted by a staff member. 1-4 conferences or laboratory periods; 1 to 4 cr.

899. Thesis

6 cr.

English

Sylvester H. Bingham, *Chairman*

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. The high school teacher may, however, pursue either degree.

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 850-898, 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 marked on the graduate level.

If a student intends to complete his work for the Master's degree in one year, he should register for three thesis credits each semester.

705. English Grammar

Mr. Goffe. Limited to students in the teacher preparation program and graduate students working for the MST degree. 3 cr. (Formerly 86)

706. Expository Writing

Limited to students in the teacher preparation program and graduate students working for the MST degree. 3 cr. (Formerly 85)

709, 710, 711. Critical Analysis

Analysis of three forms of writing: 709, exposition; 710, fiction; 711, poetry. Mr. Bingham and Mr. Richardson. (Not open to students who have had English 43, 44, 45.) 3 cr. (Formerly 87, 88, 89)

755, 756. Chaucer

Mr. Underwood. 3 cr. (Formerly 55, 56)

757, 758. Shakespeare's Plays

The major histories, comedies, and tragedies. Mr. Schultz and Mr. Yarrington. 3 cr. (Formerly 57, 58)

759. Milton

Mr. Schultz. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 59)

760. Boswell's Johnson

Mr. Maynard. 3 cr. (Not offered in 1964-65.) (Formerly 60)

761. Wordsworth

Mr. Miller. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 61)

762. Browning

Mr. Daggett. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 62)

763, 764. English Literature in the Sixteenth Century

Mr. Schultz. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 63, 64)

765, 766. English Literature in the Seventeenth Century

3 cr. (Alternate years; offered in 1964-65.) (Formerly 65, 66)

767, 768. English Literature in the Eighteenth Century

Mr. Maynard. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 67, 68)

769, 770. The English Romantic Period

Wordsworth, Coleridge, Lamb, Hazlitt, Byron, Shelley, Keats, DeQuincey. Mr. Miller. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 69, 70)

771, 772. Victorian Prose and Poetry

Major non-fictional prose from Carlyle to Stevenson and major poetry from Tennyson to Hardy. Mr. Miller. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 71, 72)

773, 774. British Literature of the Twentieth Century

Mr. Richardson. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 73, 74)

775. New England Renaissance

Emerson, Thoreau, and other transcendentalists. Mr. Daggett. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 75)

776. American Novel in the Nineteenth Century

Mr. Webster. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 76)

777. American Poetry of the Nineteenth Century

Mr. Daggett. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 77)

779, 780. American Literature of the Twentieth Century

Mr. Nicoloff. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 79, 80)

781, 782. Introduction to English Drama

The development of English drama, exclusive of Shakespeare, from the Middle Ages to the present. Mr. Yarrington. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 81, 82)

783, 784. The English Novel of the Eighteenth and Nineteenth Centuries

Mr. Bingham and Mr. Miller. 3 cr. (Formerly 83, 84)

855, 856. Chaucer

3 cr. (Formerly 155, 156)

857, 858. Shakespeare

3 cr. (Formerly 157, 158)

859. Milton
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 159)

860. Boswell's Johnson
3 cr. (Not offered in 1964-65.) (Formerly 160)

861. Wordsworth
3 cr. (Alternate years; offered in 1964-65.) (Formerly 161)

862. Browning
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 162)

863, 864. English Literature in the Sixteenth Century
3 cr. (Alternate years; offered in 1964-65) (Formerly 163, 164)

865, 866. English Literature in the Seventeenth Century
3 cr. (Alternate years; offered in 1964-65.) (Formerly 165, 166)

867, 868. English Literature in the Eighteenth Century
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 167, 168)

869, 870. The English Romantic Period
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 169, 170)

871, 872. Victorian Prose and Poetry
3 cr. (Alternate years; offered in 1964-65.) (Formerly 171, 172)

873, 874. British Literature of the Twentieth Century
3 cr. (Alternate years; offered in 1964-65.) (Formerly 173, 174)

875. The New England Renaissance
3 cr. (Alternate years; offered in 1964-65.) (Formerly 175)

876. The American Novel in the Nineteenth Century
3 cr. (Alternate years; offered in 1964-65.) (Formerly 176)

877. American Poetry of the Nineteenth Century
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 177)

879, 880. American Literature of the Twentieth Century
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 179, 180)

881, 882. An Introduction to English Drama
3 cr. (Alternate years; not offered in 1964-65.) (Formerly 181, 182)

883, 884. The English Novel of the Eighteenth and Nineteenth Centuries
3 cr. (Formerly 183, 184)

885, 886. Seminar — Problems in Medieval Literature
Mr. Underwood. 3 cr. (Formerly 185, 186)

887. Seminar — Problems in Literature and Thought, 1570-1670
Mr. Schultz. 3 cr. (Formerly 187)

888. Seminar — Problems in Milton Scholarship and Criticism
Mr. Schultz. 3 cr. (Formerly 188)

899. Master's Thesis
6 cr.

Entomology

James G. Conklin, *Chairman*

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 lec.; 1 lab.; 3 cr.

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 the Department Chairman. 2 lec.; 2 lab.; 4 cr.

709-110 Advanced Economic Entomology

Problems in applied Entomology and apiculture; 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 the Department Chairman. 1 to 3 cr.

801, 802. Graduate Entomology

Mr. Conklin and Mr. Blickle. Hours and credits to be arranged.

899, (899). Graduate Entomology. Master's Thesis

Mr. Conklin and Mr. Blickle. Hours and credits to be arranged.

Foreign Languages and Literatures

R. Alberto Casas, *Chairman*

The Department of Foreign Languages and Literatures offers courses leading to two degrees, Master of Arts and Master of Science for Teachers.

To be admitted to graduate study for the M.A. degree in a foreign language, the student must have met requirements substantially equal to those set up for an undergraduate major at the University. The student must submit an acceptable thesis embodying the results of independent investigation (equivalent

to six semester credits in courses primarily for graduate students). The thesis must be presented before April 20 of the academic year in which the degree is to be granted.

Before undertaking thesis work, the student must pass a comprehensive written examination in the language and literature of his major field of specialization. The examination will be given four times a year: January, May, August, and September. The candidate will be permitted only two opportunities to take this comprehensive examination. In case of failure in the first attempt, a re-examination may not be taken within three months.

The student must complete at least 30 credits of graduate work with a minimum of 18 credits in his major language, exclusive of the thesis. Six credits in courses in General Language and Literature, listed below, may be counted toward the degree.

A student taking a course numbered 850-890 must register for the graduate course and pass, in partial fulfillment, with a grade of B or better, the corresponding undergraduate course numbered 750-790. At the same time he must do additional work assigned by the instructor and prepare a paper on an agreed subject connected with his study. A student should not register for a graduate course if he has previously taken the corresponding undergraduate course.

To be admitted to graduate study for the M.S.T. degree in a foreign language, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in a foreign language. Courses leading to this degree will normally be chosen from Summer Session and National Defense Education Foreign Language Institute offerings and require 30 semester hours of work at the graduate level. Secondary school teachers interested in this degree should consult the Department Chairman.

General Language and Literature

772. Applied Linguistics

Designed to acquaint teachers and others with the techniques and practical application of modern structural linguistics. Mr. Lopez-Morales. *Prereq.:* Permission of the instructor. 3 cr. (Formerly 72)

773. Introduction to Romance Philology

The historical development of French and Spanish from Vulgar Latin. Phonology, morphology, syntax, semantics, etymology. Frequent reference is made to the spoken languages of today as well as to comparative semantics. Mr. Lopez-Morales. *Prereq.:* Permission of instructor. 3 cr. (Offered in 1964-65. (Formerly 73)

880. Foreign Language Institute

The work at this institute will consist of: applied linguistics (techniques and practical application of modern structural linguistics in the teaching of

a modern foreign language); methods and measurements in the teaching of a foreign language (objectives, methods and devices both in the classroom and in the language laboratory); intensive practice in the spoken language and language analysis; and culture and civilization (dealing with the most significant aspects and trends of the areas where the target language is spoken). *Prereq.:* Admission to Institute. 3 to 9 cr. (Formerly 193)

LANGUAGES-EDUCATION (LANG-ED) 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. *Prereq.:* Intermediate French, German, Spanish; and grade of C or better in Ed. 758 or one year's teaching experience. (Formerly 91)

FRENCH

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 LaBruyrè. Lesage, the beginning of the philosophical movement. Conducted in French. *Prereq.:* Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 59-60)

764. EIGHTEENTH CENTURY FRENCH LITERATURE AND THOUGHT

The literary and philosophical currents, including Montesquieu, Marivaux, Rousseau, Voltaire, the encyclopedists, Beaumarchais and others. Conducted in French. *Prereq.:* Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 64)

767-768. NINETEENTH CENTURY FRENCH LITERATURE

767: Romanticism; Mme. de Stael, Chateaubriand, Lamartine, Hugo, Vigny, Musset. 768: Late Romanticism; Realism; Stendahl, Balzac, Flaubert, Hugo, the Parnassian school. Conducted in French. *Prereq.:* Fr. 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 67-68)

770. INTRODUCTION TO MODERN FRENCH POETRY

Baudelaire, Rimbaud, Mallarmé, Valéry, and others. *Prereq.:* 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 70)

781-782. CONTEMPORARY FRENCH NOVEL AND THEATER

781: Zola, the Concourts, Proust, Gide, Becque, Maeterlinck, and others. 782. Mauriac, Malraux, Bernanos, Sartre, Camus, Claudel, Pagnol, Anouilh, Giraudoux, and others. Conducted in French. *Prereq.:* Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 81-82)

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 cr. (Alternate years; not offered in 1964-65.) (Formerly 90)

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. *Prereq.:* Permission of the Section Supervisor. Variable credit. (Formerly 73, 74, 75, 76)

859-860. French Literature of the Seventeenth Century

Prereq.: Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 159-160))

864. Eighteenth Century French Literature and Thought

Prereq.: Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 164)

867, 868. Nineteenth Century French Literature

Prereq.: Fr. 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 167-168)

870. Introduction to Modern French Poetry

Prereq.: Fr. 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 170)

881-882. Contemporary French Novel and Theater

Prereq.: Fr. 506. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 181-182)

890. Advanced Language and Style

Prereq.: Open to qualified students who have had a minimum of six hours of French courses numbered 641 and above. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 190)

895, 896. Special Studies in French Language and Literature

Prereq.: Permission of Section Supervisor. Variable credit. (Formerly 173, 174, 175, 176)

German

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. *Prereq.:* Ger. 505, 506. 3 cr. (Alternate years; not offered 1964-65.)

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. *Prereq.:* Ger. 505, 506. 3 cr. (Alternate years; not offered 1964-65.)

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. *Prereq.:* Ger. 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 57-58)

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. *Prereq.:* Ger. 506. 3 cr. (Alternate years; offered 1964-65.)

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. *Prereq.:* Ger. 506. 3 cr. (Alternate years; offered 1964-65.)

763-764. German Literature Since 1880.

From Naturalism to the present. Reading, interpretation, and critical analysis of prescribed prose, drama and poetry of Hauptmann, Hofmannstal, Rilke, Mann, Kafka. *Prereq.:* Ger. 506. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 63-64)

791, 792. History and Development of the German Language and 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. *Prereq.:* Ger. 505, 506. 3 cr.

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. *Prereq.:* Permission of Section Supervisor. Variable credit. (Formerly 73, 74, 75, 76)

855. German Literature of the Age of the Baroque

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; not offered 1964-65.)

856. German Literature of the Age of Enlightenment

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; not offered 1964-65.)

857-858. The Age of Goethe

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; not offered 1964-65.) (Formerly 157-158)

859-860. German Romanticism

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; offered 1964-65.)

861-862. The Age of Realism

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; offered 1964-65.)

863-864. German Literature Since 1880

Prereq.: German Civilization and Literature. 3 cr. (Alternate years; not offered in 1963-64.) (Formerly 163-164)

891, 892. History and Development of the German Language and Advanced Stylistics

Prereq.: German Civilization and Literature. 3 cr.

895, 896. Special Studies in German Literature

Prereq.: Permission of Section Supervisor. 3 cr. (Formerly 173, 174, 175, 176)

Latin

751-752. Roman Satire

Horace's 'Satires' and 'Epistles', selected works of Persius, Juvenal, and Martial, and a study of Roman life and thought as reflected in these works. *Prereq.:* Lat. 506 or equivalent. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 51-52)

753-754. The Historians

Livy, Suetonius, and Tacitus in selected works. Illustrated lectures and outside readings on the historical, social, and political background of Rome, essential to the student or teacher of Latin. *Prereq.:* Lat. 506 or equivalent. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 53-54)

755-756. The Golden Age

Roman literature of the classical period, particularly the works of Caesar, Cicero, and Virgil. *Prereq.:* Lat. 506 or its equivalent. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 55-56)

Latin-Education (Lat-Ed) 791-792. Problems in the Teaching of High-School Latin

Methods, objectives, and problems of teaching high-school Latin carried on concurrently with work in composition and conversation. *Prereq.:* Permission of the instructor. 3 cr. (Not offered in 1964-65.) (Formerly 91-92)

795, 796. Special Studies in Latin Literature

Guided studies in special topics with training in bibliography and organization of material. Examples of topics which may be selected by instructor and student are: (1) Roman Comedy and Elegy, (2) The Roman Epic, (3) Roman Drama, (4) The Silver Age. Mr. Doig. *Prereq.:* Permission of Section Supervisor. Variable credit. (Formerly 71, 72, 73, 74)

851-852. Roman Satire

Prereq.: Latin Prose and Poetry or the equivalent. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 151-152)

853-854. The Historians

Prereq.: Latin Prose and Poetry or the equivalent. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 153-154)

855-856. The Golden Age

Prereq.: Latin Prose and Poetry or the equivalent. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 155-156)

895, 896. Special Studies in Latin Literature

Prereq.: Permission of Section Supervisor. Variable credit. **(Formerly 171,** 172, 173, 174)

Spanish

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, La Celestina* and *Don Quijote,* and their social and historical background. The course will cover early Spanish literature up to Cervantes. *Prereq.:* Sp. 505 or equivalent. 3 cr. (Formerly 51)

752. Drama and Poetry of the Siglo de Oro

The social background of the baroque period. Readings of the representative plays of Lope de Vega, Calderon, Alarcon, Tirso de Molina, and the poetry of Gongora and Quevedo. Development of the prose of the period. *Prereq.:* Sp. 506 or equivalent. 3 cr. (Formerly 52)

755. Literature of the Nineteenth Century

Preliminary survey of the Eighteenth Century and readings and discussion of the main literary movements and writers of the Nineteenth Century, such as Quintana, Espronceda, Zorrilla, Larra, Duque de Rivas, Becquer, Perez Galdos, Valera, Pereda, Clarin, and Echegaray. Social and historical background of Spain in relation to Nineteenth Century thought in Europe. *Prereq.:* Sp. 506 or equivalent 3 cr. (Formerly 55)

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. Jimenez, Ortega y Gasset, Garcia Lorca, Perez de Ayala, Casona, Benavente, and a survey of Spanish literature and thought since 1939. *Prereq.:* Sp. 506 or equivalent. 3 cr. (Formerly 56)

765, 766. Spanish American Literature

The main themes of Spanish American literature through the readings of the works of the most representative authors along with an historical, social and geographical background of the New World. *Prereq.:* Sp. 506 or equivalent. 3 cr. (Formerly 65, 66)

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) 18th, 19th, or 20th century literature in Spain; (2) literature and civilization in Spain in the Golden Age; (3) Cervantes; (4) the literature of individual Latin-American countries. Staff. *Prereq.:* Permission of Section Supervisor. Variable credit. (Formerly 73, 74, 75, 76)

851. Spanish Literature up to 1600

Prereq.: Sp. 505 or equivalent. 3 cr. (Formerly 151)

852. Drama and Poetry of the Siglo De Oro

Prereq.: Sp. 506 or equivalent. 3 cr. (Formerly 152)

855. Literature of the Nineteenth Century

Prereq.: Sp. 506 or equivalent. 3 cr. (Formerly 155)

856. Contemporary Spanish Literature

Prereq.: Sp. 506 or equivalent. 3 cr. (Formerly 156)

865-866. Spanish American Literature

Prereq.: Sp. 506 or equivalent. 3 cr. (Formerly 165-166)

895, 896. Special Studies in Spanish and Literature

Prereq.: Permission of Section Supervisor. 3 cr. (Formerly 173, 174, 175, 176)

Forestry

Paul E. Bruns, *Chairman*

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.

629. Silviculture

The theory and techniques of applying ecological knowledge to the control of establishment, composition, and growth of forest stands for economic purposes. Field practice including marking of stands for various kinds of cutting and for cultural treatment. Mr. Hocker. *Prereq.:* For. 425, For. 527 or Bot. 742. 2 lec.; 1 lab.; 3 cr.

650. Logging Economics

Application of economic principles to the study of timber harvesting. The use of quantitative methods in developing logging cost and production functions. Field problems. Mr. Donnelly. *Prereq.:* For. 528, For. 544 or equivalents. 2 lec.; 1 lab.; 3 cr.

651. Forest Utilization

Methods of milling in the chief lumber-producing regions of the United States; forest products, their manufacture and markets; special problems of the lumber business. *Prereq.:* Permission of the instructor. 2 lec.; 1 4-hr. lab.; 4 cr.

659. Forest Protection

Principles of protection from fire, insects, fungi, climatic extremes, and other injurious agencies. Principles are illustrated by protection problems of northeastern forests. Emphasis on the development of resistant forest stands. *Prereq.:* Ent. 506, Bot. 751 or equivalent. 2 lec.; 1 lab.; 3 cr.

661. Forest Management

The management of forest areas on an economic and ecological basis. The integration and application of business methods and the technical phases of forestry. Mr. Bruns. *Prereq.:* Permission of the instructor. 3 lec.; 1 lab.; 4 cr.

701. Statistical Methods II

An intermediate course in statistics. All students elect the applied phase with the basic phase optional for additional credit. Applied phase presents

concepts of statistical models, tests of significance, analysis of variance in one-way and multiway classifications, and factorial experiments. Introduction to covariance, multiple regression, and analysis with unequal subclass numbers; introduction to chi-square tests, discrete distributions, non parametric statistics, and sampling. Basic phase parallels and supplements applied phase; algebraic derivation of computing formulae, study of models and derivation of expected values; matrix representation of experimental design and multiple regression models; introduction to least squares. Mr. Barrett. *Prereq.:* An elementary statistics course. 3-4 cr.

730. Artificial Regeneration

Forest tree improvement, reproduction, collection and testing of forest tree seed, nursery management and out-planting of seedlings, direct seeding of forest stands, planting site surveys. Mr. Hocker. *Prereq.:* For. 527. 2 lec.; 1 lab.; 3 cr.

734. Forest Fish and Game

The characteristics of the more important species present in Northeastern forests, together with some consideration of the management techniques applicable to each. Elective with approval of the instructor. 2 lec.; 1 lab.; 3 cr.

742. Forest Engineering

Design of logging road systems with an emphasis on the economics involved. Field work in road layout. Mr. Donnelly. *Prereq.:* Permission of the instructor. Two weeks' field session in June; 3 cr.

746. Forest Management Resource Survey

Forest land use coordination. Multiple uses treated separately and as integrated concurrent uses of forested lands. Forest management for water, recreation, wildlife and range benefits. *Prereq.:* Permission of the instructor. 3 lec.; 1 lab.; 4 cr.

755, 756. Forest Game Management

Readings and discussions on the properties of game populations, and the various phases of management, including public relations. The principles of forest game management and the preparation of a working plan for the management of forest and wildlife resources on a specified area. The student may be required to spend several week-ends working with the State Fish and Game Department, helping with investigational projects. 2 lec.; 1 4-hr. lab.; 4 cr.

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. Mr. Barrett. *Prereq.:* Permission of instructor. 2 lec.; 1 lab.; 3 cr.

763. Forest Recreation

The extent, developments, and conflicts in the recreational use of wild lands of North America. Relationships to the conservation of natural resources are considered. *Prereq.:* Permission of the instructor. Mr. Wallace. 3 lec.; 3 cr.

764. Forest Industry Economy

Economy in productive enterprise — logging and manufacturing of forest products; control of harvesting costs as a factor in intensifying applied

forest management; planning for minimum cost operations. Mr. Wallace. *Prereq.:* Permission of the instructor. 2 lec.; 1 lab.; 3 cr.

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. 2 rec.; 2 cr. *Prereq.:* Permission of the instructor.

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. Wallace, Mr. Hocker, and others. 2 cr. *Prereq.:* Permission of the instructor.

805. Utilization Seminar

Conferences, discussions, and reports on assigned topics. Consideration of current literature and developments in the general field of wood utilization. *Prereq.:* Permission of the instructor. 2-hour seminar; 2 cr.

806. Logging Economics Seminar

Conferences, discussions, and reports on assigned topics. Considerations of current developments in the field of raw material procurement. Mr. Donnelly. *Prereq.:* Permission of the instructor. 2-hour seminar; 2 cr.

809, 810. Wildlife Management Seminar

Discussions and assigned reports on current investigations and developments in wildlife management. *Prereq.:* Undergraduate courses in wildlife management. 2-hour seminar; 2 cr.

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. *Prereq.:* Permission of the instructor. 2 lec.; 1 lab.; 3 cr.

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. Mr. Barrett. *Prereq.:* Permission of the instructor. 2 cr.

833. Forest Protection Seminar

Discussion and special problems based on the principles and techniques of forest protection. *Prereq.:* For 659 or equivalent. 3 cr.

861, 862. Investigations in (1) Forest Ecology, (2) Photogrammetry, (3) Forest 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. *Prereq.:* Permission of the instructor. 2-4 cr.

899. Thesis

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

Government

John T. Holden, *Chairman*

A candidate for the degree of Master of Arts in Government is required to complete at least 30 credits of acceptable work. In addition the candidate must show evidence through a written examination of a mastery in three basic areas in Government agreed upon between the student and his adviser. At the option of the Department Chairman, any student may be orally examined on his thesis by a committee selected by the Chairman and approved by the Dean of the Graduate School. He shall show evidence of competence in one foreign language or in statistics.

Generally his program shall consist of 18 credits in Government courses, including 6 credits for the thesis, and 12 credits in courses from related fields. Government courses shall be selected from those numbered 800-899. With the consent of the adviser, 3 credits may be selected in courses numbered 700-799.

The Department also offers a Master of Public Administration degree.

717. Continental European Political Parties

The relationship of theories of representation and political parties to historical circumstance. Following an appraisal of today's party systems, chronological treatment serves to show how changes within and among political parties are connected with the changing role parties play in the political process. Mr. Wurzburg. *Prereq.:* Permission of the Department. 3 cr.

726. Pressure Groups and the Governmental Process

Political interest groups as an unofficial "third house" of American national and state legislatures. The efforts by pressure groups to influence public officials by lobbying, propaganda, and direct political action. Mr. Ford. *Prereq.:* Gov. 406. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 54)

731. 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. Mr. Howard. *Prereq.:* Gov. 406 or Soc. 400. 3 cr. (Formerly 57)

741. Administration of Justice

The nature, sources, and problems of the law as distinguished from other forms of social control. The course is analytical and critical, tracing the

origin and development of legal institutions from primitive times to the present and evaluating the modern role of judge, jury, and counsel in the administration of justice. The law in action, i.e., law as it is applied by courts and practiced by lawyers rather than as it is formulated by the legislative and executive branches. Mr. Dishman. 3 cr. (Formerly 51)

742. The Supreme Court and the American Constitution

Stresses the basic constitutional principles on which the American political system is founded and their application to present-day social, political, and economic problems. The powers of Congress, the President, and the federal courts and the constitutional limitations by which their respective powers are checked. Mr. Dishman. *Prereq.:* Gov. 406. 3 cr. (Formerly 52)

745. 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 cr. (Formerly 55)

746. 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 cr. (Not offered in 1964-65.) (Formerly 56)

751. 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, Viet Minh, Thailand, Burma, Malaya, and Indonesia. Mr. Holden. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 69)

752. 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. *Prereq.:* Gov. 405 or permission of instructor. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 90)

754. Governments of Latin America

A comparative study of the politics and governing systems of Latin America with some consideration given to regional arrangements. *Prereq.:* Gov. 405 or permission of instructor. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 92)

763. Political Thought in the West

The principal political theories from Plato and Aristotle to the beginning of the modern liberal tradition. The growth and development of political thinking and institutions in terms of the development of modern government. The development of the modern nation state and its fundamental institutions. Mr. Jaffe. 3 cr. (Formerly 63)

764. Modern Political Thought

Modern Western political thought from the emergence of the nation state to the present. The meaning and growth of the basic patterns of thought on the Continent and in England, including liberalism, democracy, nationalism, socialism, communism, and facism. The contributions of American political thought as it grew from its English origins to the development of the American constitutional system. Mr. Jaffe. 3 cr. (Formerly 64)

765. Contemporary Political Theory

A survey and analysis of contemporary political theories. The crisis in democratic thought, totalitarian ideology, the search for scientific political theory. *Prereq.:* Gov. 763, 764 or permission of instructor. 3 cr. Mr. Jaffe. (Not offered in 1964-65.)

771, (771). Research in Government Problems

An individual research project in one of the fields of government, e.g., local or state administration, comparative government, international relations, international organization, political theory, politics, or public law to be prepared under the direction of the instructor. Emphasis on the methods and sources of research in government. Mr. Dishman. 3 cr. (Formerly 65)

776. Natural Resources Policy and Administration

The development and administration of public policy on land, water, and mineral resources. Attention will be given to the historical development of governmental action in each of these areas, political conflicts on policy goals, and the administrative structure for carrying out current policies. *Prereq.:* Gov. 406. 3 cr. (Not offered in 1964-65.) (Formerly 58)

779. Public Policy and Regionalism

3 cr. (Not offered in 1964-65.) (Formerly 67)

797, 798. 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 the instructor is required. Mr. Holden, Mr. Dishman, Mr. Jaffe, Mr. Ford and Mr. Howard. 3 cr. (Formerly 97)

Reading and Research in Government and Political Science

With the advice and consent of the instructor, graduate students in social science who demonstrate the ability to do independent work may register for the following reading and research courses. The student will attend the regular lectures, meet the required examinations, follow a prescribed reading program, and write a paper in lieu of a final examination. 3 cr.

817. Continental European Political Parties

Mr. Wurzburg. 3 cr.

826. Pressure Groups and the Governmental Process
Mr. Ford. 3 cr. (Formerly 154)

831. The Administrative Process
Mr. Howard. 3 cr. (Formerly 157)

832. Comparative Administration
3 cr. (Not offered 1964-65.) (Formerly 160)

833. American National, State, and Local Administration
This generally follows Gov. 831, The Administrative Process, and deals with various specialized aspects of administrative practice in the United States, including policy formation in administrative settings, rule making, administrative adjudication, and policy control. Mr. Howard and others. 3 cr. (Formerly 161)

834. Administrative Decision-Making
3 cr. (Formerly 162)

841. Administration of Justice
Mr. Dishman. 3 cr.

842. The Supreme Court and the American Constitution
Mr. Dishman. 3 cr. (Formerly 152)

845. World Politics
Mr. Holden. 3 cr. (Formerly 155)

846. Foreign Policies of the Great Powers
Mr. Holden. 3 cr. (Not offered 1964-65.) (Formerly 156)

851. Contemporary Southeast Asia
Mr. Holden. 3 cr. (Not offered in 1964-65.) (Formerly 169)

852. Governments of Emerging Countries
3 cr. (Not offered in 1964-65.)

854. Governments of Latin America
3 cr. (Not offered in 1964-65.)

863. Political Thought in the West
Mr. Jaffe. 3 cr. (Formerly 163)

864. Modern Political Thought
Mr. Jaffe. 3 cr. (Formerly 164)

865. Contemporary Political Theory
Mr. Jaffe. 3 cr.

876. Natural Resources Policy and Administration
3 cr. (Not offered in 1964-65.) (Formerly 158)

879. Public Policy and Regionalism
3 cr. (Not offered in 1964-65.)

897, 898. Seminar in Government
Mr. Holden, Mr. Dishman, Mr. Jaffe, Mr. Ford, and Mr. Howard. 3 cr. (898 not offered in 1964-65.) (Formerly 197)

899. Master's Thesis
6-9 cr.

History

Marion E. James, *Chairman*

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 22 to 24 of this catalogue. 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. Marston. 3 cr. (Formerly 51, 52)

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 cr. (Formerly 87, 88)

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 cr. (Not offered in 1964-65.) (Formerly 85, 86)

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 cr. (Formerly 83, 84)

739, 740. Three Medieval Civilizations

A study of 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. Stress will be put on religious, literary and scholarly survivals and innovations from 400 A.D. to 1400 A.D. Mr. Jones. 3 cr. (Formerly 65, 66)

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 cr. (Formerly 67)

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 cr. (Formerly 69)

756. Twentieth Century Europe

European history 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 cr. (Formerly 70)

763, 764. History of Russia

The development of the Russian state from its foundation to its present status as a world power, 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 cr. (Formerly 71, 72)

781. History of Modern China, 1850-1950

The struggles of a great Asian nation to modernize. Political, social, and cultural developments, the internal and external factors in the decline of the Chinese Empire, efforts to transplant western political institutions to China, the westernization of China's intellectuals, the growth of the Kuomintang and of the Chinese Communist Party, and the impact of World War II. Mr. Linden. 3 cr.

(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 Phys. Sci. (789). Mr. Schneer. *Cannot be used for credit in History without permission of the History Department. Prereq.:* Permission of adviser and instructor. 3 cr.

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 Hist. 503, 504; six credits in other history courses, exclusive of Hist. 401, 402; six credits from American Government, Principles of Economics, or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. 3 cr. (Formerly 91)

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. Marston. *Prereq.:* Permission of the instructor. 3 cr. (Formerly 113, 114)

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. *Prereq.:* A course in United States history and the permission of the instructor. 3 cr. (Alternate years; offered in 1964-65.) (Formerly 187, 188)

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. *Prereq.:* A course in United States history and the permission of the instructor. 3 cr. (Alternate years; not offered in 1964-65.) (Formerly 185, 186)

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. Mr. Gilmore. *Prereq.:* A course in Modern European History and permission of the instructor. 3 cr. (835 will not be offered in 1964-65; 836 will be offered.) (Formerly 119, 120)

863, 864. Seminar in Russian History
For students who wish to concentrate on specific problems in Russian history, such as the reform movements of the Nineteenth Century, the Russian Revolution, or intellectual movements in Russia. Emphasis on wide reading, both in primary and secondary works, on discussion of problems, and on research papers. Mr. Heilbronner. *Prereq.:* A course in Russian History and permission of the instructor. 3 cr. (863 will be offered in 1964-65; 864 will not be offered.) (Formerly 171, 172)

895, 896. Reading and Research in 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. *Prereq.:* Permission of the instructor. 3 cr. (Formerly 190)
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. Topical Studies

899. Master's Thesis
6 cr.

Home Economics

Marjory Wybourn, *Chairman*

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 and community services.

Each student's program will be planned to achieve personal and professional objectives of the individual and will 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 Ecnomics 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: H.E. 897, Review of Research, and H.E. 898, Research Project or H.E. 899, Thesis.

757, (757). Home Management

The management of individual and family resources as related to human needs, values, and goals throughout the life cycle of the family. 3 cr.

765. History of Costume

Western world costume from primitive times to the present. The influence of social, religious, and political conditions of the eras studied to costume evolution. 3 cr.

767. Fundamentals of Fashion

Economic, psychological, and sociological problems inherent in the field of fashion. The development of the fashion industry. 2 cr.

769. Advanced Textiles

Investigation and evaluation of fabrics in everyday use. Consumption of textiles with emphasis on economic and social implications. *Prereq.:* H.E. 404 or equivalent. 3 cr.

771. Experimental Foods

Application of the experimental method of study to problems in foods. Methods of evaluating food quality. *Prereq.:* H.E. 418 and permission of the instructor. Includes lab. 3 cr.

778. Food Trends and Developments

Investigation and evaluation of developments in food production, preparation, and preservation. Instructional field trips constitute a major portion of class time. 3 cr.

783, (783). Family Development

Consideration of relationships and individual growth and development within the home and community at all stages of the family life cycle. Understanding of different cultures and ways of life. 3 cr.

791. Methods in Home Economics Education

Home economics education in the school program, curriculum materials, methods, and resources in teaching home economics. 3 cr.

795, (795). Projects in Child Development

Discussion, conferences, and supplementary projects based upon special interests of the student. Work with children in the University Nursery School

or in other situations. *Prereq.:* H. E. 486 and permission of the instructor. 1-3 cr. each semester; maximum 6 cr.

797. Nutrition Seminar

Critical review of literature in the field of nutrition with emphasis on experimental data on which principles of human nutrition are based. *Prereq.:* Permission of the instructor. 3 cr.

(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. *Prereq.:* H. E. 791 or equivalent. 2-4 cr.

895, (895). Projects in Food and Nutrition

The student, under the guidance of the instructor, may select a study, creative project, or field experience for independent work in the area of food and nutrition. 1-3 cr. each semester; maximum of 6 cr.

(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 cr. each semester; maximum of 6 cr.

897. Review of Research

Survey, evaluation, and use of research in the field of Home Economics. An introduction to methods and techniques used in defining a problem for study, collecting data, analyzing, and writing a report. 2 cr.

(898), 898. Research Project

A study or project which may be selected in lieu of a thesis. To be taken concurrently with H. E. 897. 2-4 cr.

899. Thesis
6 cr.

Horticulture

(See Plant Science)

Mathematics

M. Evans Munroe, *Chairman*

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.

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: (1) 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. (2) A comprehensive examination based primarily on material in the courses taken.

Doctor of Philosophy

Admission requirements: Same as for M.S.

Degree requirements: (1) Course work as prescribed by the Department. This will normally include all the courses numbered 830-840 together with several courses numbered 860-899. (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 will test the candidate's knowledge of advanced mathematics generally and, unlike the comprehensive examinations for Master's degrees, will not necessarily be confined to the subject matter taken. (5) Thesis. This is the principal item in the Ph.D. program. New and original results will be required. At present, thesis work is available in the fields of algebra, functional analysis, and topology only.

With the approval of the department concerned, the following courses may be applied to graduate degrees in certain fields. They may not be applied to graduate degrees in Mathematics.

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. *Prereq.:* Consent of instructor. 3 cr.

651. 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. *Prereq.:* Math. 541. 3 rec.; 4 cr.

652. 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. *Prereq.:* Math. 651. 3 rec.; 4 cr.

653-654. Methods and Techniques of Modern Computation

Methods of numerical analysis which are believed to be particularly suitable for high-speed computation, including some newly developed methods. Methods for making analytical approximations. An introduction to programming techniques, assembly and compiler programs, interpretive systems and symbolic operations. In the laboratory portion of the course, the practical aspects of modern computation, such as loss of precision, round-off error, overflow and underflow, etc., will be illustrated by means of short problems on both the desk calculator and the digital computer in the UNH Computation Center. A long-range project for investigation on the computer will be assigned. *Prereq.:* Math. 541. 3 rec.; 1 lab.; 4 cr.

A maximum of four of the following courses may be applied to the degree of M.S. in Mathematics.

741. Mathematical Statistics I

Sampling theory; estimation of parameters; the multivariate normal distribution. *Prereq.:* Math. 542. 3 rec.; 4 cr.

742. Mathematical Statistics II

Testing statistical hypotheses; confidence intervals; regression and correlation; non-parametric methods, and other topics. *Prereq.:* Math. 741. 3 rec.; 4 cr.

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. *Prereq.:* Math. 426. 3 rec.; 4 cr.

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. *Prereq.:* Math. 531. 3 rec.; 4 cr.

761. Higher Algebra I

The integers; the rational and complex number systems; congruences; polynomials; groups; rings; integral domains; fields. *Prereq.:* Math. 531. 3 rec. 4 cr.

762. Higher Algebra II

Vector spaces and transformations; matrices and determinants. *Prereq.:* Math. 531. 3 rec.; 4 cr.

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. *Prereq.:* Math. 531. 3 rec.; 4 cr.

768. Real Analysis II

The Riemann integral; uniform convergence; double and iterated limits; applications of double limit theorem to series, limits under the integral sign and existence theorems for differential equations. *Prereq.:* Math. 531. 3 rec.; 4 cr.

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. *Prereq.:* Math. 761. 3 rec.; 4 cr.

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. *Prereq.:* Math. 426. 3 rec.; 4 cr.

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 Bogoliouboff. *Prereq.:* Math. 541. 3 rec.; 4 cr.

783. Introduction to Differential Geometry

A first course in the metric differential geometry of curves and surfaces in Euclidean space. *Prereq.:* Math. 541. 3 rec.; 4 cr.

784. Introduction to Topology

Elementary point-set topology in metric and topological spaces, in particular the real line and plane. *Prereq.:* Math. 531. 3 rec.; 4 cr.

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; first order partial differential equations of the second order. *Prereq.:* Math. 531. 3 rec.; 4 cr.

788. Complex Analysis

The complex number system; analyticity; elementary functions; Cauchy integral theorem and formulas; Taylor and Laurent series; singularities and residues; conformal mapping. *Prereq.:* Math. 531. 3 rec.; 4 cr.

The following courses may be applied to the degree of M.S.T. 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 cr.

803-804. Higher Algebra for Teachers

The integers, integral domains, and topics from number theory; equivalent relations and congruences; real numbers, complex numbers, and fields; polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. 3 cr.

805-806. Higher Geometry for Teachers

Systems of postulates of various geometrics; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. 3 cr.

807-808. Higher Analysis for Teachers

The real number system; variables, functions, and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. 3 cr.

809-810. Probability and Statistics for Teachers

Permutations and combinations; discrete sample spaces; Markov chains; random variables; descriptive statistics; binomial and normal distributions; goodness of fit; estimation of parameters; testing of hypotheses. 3 cr.

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 cr.

816. Theory of Numbers for Teachers

Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. 3 cr.

817. Theory of Sets and Elementary Logic

An introduction. 3 cr.

819. The Real Number System

A postulational approach. Brief discussion of algebraic structures. Introduction to the sequences, limits, and continuity. 3 cr.

821. Modern Undergraduate Mathematics and the High School Program

Selected readings in several of the new college freshman texts as a study of the background now expected of a college freshman. 3 cr.

822. Trends and Developments in High School Mathematics

Some of the revised high school curricula now in operation. 3 cr.

823. Modern Algebra and Analysis in the High School

Topics in modern algebra and analysis which are currently being introduced in high school curricula, with discussions concerning when and how these topics can best be introduced. 3 rec.; 3 cr.

826. A Modern Approach to Geometry

The foundations and development of Euclidean geometry, with emphasis on the recent School Mathematics Study Group's recommendations in the field of high school geometry. 3 cr.

828. Selected Topics in Algebra and Analysis

Topics designed to implement the teacher's previous institute training in these fields. 3 cr.

829. Directed Reading and Essay

A selected topic in mathematics and its applicability to the high school program. The student will prepare an essay. 3 cr.

The following are the basic courses for both the M.S. and Ph.D. in Mathematics.

831. Set Theory

Foundations of the theory of sets; ordinal and cardinal numbers; Zorn's lemma; applications. 3 cr.

833-834. Algebra

Groups; theory of rings and ideals; fields and their transcendental and algebraic extensions; valuation theory; Galois theory; algebraic numbers. 3 cr.

835-836. Real Analysis

The theory of measure as developed by Lebesgue, Caratheodory, and others; the definitions and basic properties of the Lebesgue integral. Related topics will be considered with the choice varying from year to year. Sample supplementary topics; foundations of probability theory, Fourier series, Banach spaces, topological groups and Haar measure, the Daniell integral. 3 cr.

837-838. Complex Analysis

Complex numbers; analytic functions; complex integration; representation theorems; theory of residues. 3 cr.

839-840. Topology

General topology. 3 cr.

848. Geometry

Metric differential geometry of curves and surfaces in Euclidean spaces; tensor analysis; Riemannian geometry. 3 cr.

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 cr.

855-856. Applied Mathematics

Calculus of variations, integral equations; operator theory; distributions; Hilbert spaces. 3 cr.

The following are advanced courses primarily for Ph.D. candidates, though they may be elected by qualified M.S. candidates. In each of these the content will vary from year to year. Thus, with the consent 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 cr.

863, 864. Topic: in Analysis

Measure theory; calculus of variations; integral equations; boundary value problems; orthogonal series; theory of approximation; analytic number theory; Riemann surfaces. 3 cr.

865, 866. Topics in Topology

Algebraic topology; theory of sheaves; dimension theory; Riemann surfaces; homotopy theory. 3 cr.

867, 868. Topics in Geometry

Convexity; projective geometry; differential geometry; tensor analysis. 3 cr.

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 cr.

871, 872. Topics in Differential Equations

Boundary value problems; asymptotic behavior and stability theory; nonlinear equations; dynamic systems; classical theory of partial differential equations; functional analysis and partial differential equations. 3 cr.

873, 874. Topics in Applied Mathematics

Linear and dynamic programming; differential equations; special functions. 3 cr.

875, 876. Topics in Probability and Statistics

Stochastic processes. 3 cr.

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 cr.

999. Ph.D. Thesis

9 cr.

Mechanical Engineering

Robert W. Corell, *Chairman*

The Mechanical Engineering Department offers specialization in materials, thermodynamics, and mechanics leading to the degree of Master of Science in Mechanical Engineering. The program provides the background required for careers in research and development, teaching or 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 be required to prepare and present an approved thesis unless excused by the Department. An oral examination covering the candidate's graduate work will be given whether or not a thesis is presented. If excused from the thesis requirement, the student must present a paper, the subject and scope of which shall be approved by his adviser.

643. Machine Design and Analysis

Analysis and design of mechanical elements and systems, utilizing and developing further the fundamentals of strength of materials and dynamics. *Prereq.:* M.E. 526, 527, Math. 541. 3 cr.

644. Mechanical Vibrations

Analysis of vibratory motion for discrete mechanical systems. *Prereq.:* Math. 541. 3 cr.

653. Heat Transfer

Analysis of heat transfer phenomena. Steady-state and transient conduction, radiation and convection. Applications to heat exchangers. *Prereq.:* M.E. 534, Math. 541. 3 cr.

657-658. Heat and Power Systems

The analysis of problems relating to heat and power systems and to energy transfer and transmission in general. The principles of thermodynamics, fluid flow, combustion, heat transfer, and other engineering sciences will be utilized and developed further. *Prereq.:* M.E. 534, 536, 538. 2 lec.; 1 lab.; 3 cr.

663. Materials II

Behavior of metals, plastics, and ceramics in engineering environments. Non-equilibrium multiphase relations, diffusion, nucleation of phases, dislocation models of creep and relaxation, ductile and brittle modes of failure, thermal stresses, modification of bulk and surface properties through deformation and heat treating. Laboratory work includes observation of properties by classical mechanical methods. *Prereq.:* M.E. 522. 2 lec.; 1 lab.; 3 cr.

664. X-Ray Metallography

Theoretical and experimental studies of X-ray diffraction and microradiography. Production of X-rays; directions and intensities of diffracted beams; Laue and Debye-Scherrer photographs, size, perfection, and orientation of grains; phase diagram determinations; stress measurement. *Prereq.:* M.E. 522 or permission of instructor. 3 cr.

671. Naval Architecture I

Introduction to ships — nomenclature and types. Geometry and hull form delineation. Hydrostatic characteristics of freely floating, partially waterborne, and damaged ships. Hydrostatic characteristics of submerged bodies. Introduction to ship strength. Computer application to problems. *Prereq.:* M.E. 527 (may be taken concurrently). 3 cr.

691. Engineering Economy

The principles which form the basis of engineering procedures for obtaining the highest ratio of utility to cost. *Prereq.:* Senior standing. 3 cr.

692. Industrial Management

Principles and methods of industrial management, designed to give students a working knowledge of modern industrial practice, with particular emphasis on the engineering viewpoint. *Prereq.:* Senior standing. 3 cr.

695-696. Mechanical Engineering Project

Investigation of problems or areas germane to mechanical engineering. *Prereq.:* Permission of Department. 1-3 cr.

697-698. Mechanical Engineering Seminar

Student reports and discussions of recent developments. *Prereq.:* Senior standing. 1 cr.

699. Undergraduate Thesis

An investigation or research of some mechanical engineering problem. Elective for seniors in Mechanical Engineering. *Prereq.:* Permission of the Department. 2 cr.

701. Thermodynamics I

Energy. Simple illustrations of statistical equilibrium, fluctuations, equilibration, entropy production, irreversibility, extensiveness, free energy, partition function. Melting. Particle velocities in a simple gas. Components and phases. Thermodynamic potentials, fundamental equations, chemical potentials. Non-equilibrium parameters. Equations of state, flow, transport. Charts. *Prereq.:* M. E. 533. 3 cr.

727. Advanced Strength of Materials

Energy methods; beams on elastic foundation; bending and buckling of thin plates; membrane stresses in shells; numerical methods. *Prereq.:* M.E. 527. Math 651. 3 cr.

729. Kinematics

The classical vector equations of relative motion are used to analyze mechanisms of varying complexity. By the use of descriptive geometry the vector equations are applied to three dimensional motion and graphical solutions in three dimensions are obtained. Analytical methods are also used and space linkages analyzed. *Prereq.:* M. E. 526. 1 lec.; 2 labs.; 3 cr.

751. Gas Dynamics

Basic equations of motion applied to compressible, ideal fluid flow. Normal and oblique shock waves. Vorticity and circulation. Irrotational flow. Linear approach to two-dimensional flow problems. Method of characteristics. *Prereq.:* M. E. 534, 536. Math. 541. 3 cr.

755. Internal Combustion Engines

Thermodynamics applied to spark ignition and compression ignition engines. Fuels, carburetion, fuel injection, lubrication, performance. *Prereq.:* M. E. 533. 2 lec.; 1 lab.; 3 cr.

756. Turbomachinery

Thermodynamics and fluid flow principles applied to rotating machinery. *Prereq.:* M. E. 534, 536. 2 lec.; 1 lab.; 3 cr.

772. Naval Architecture II

Hydrodynamic resistances of surface ships and submerged bodies. Model testing theory. Powering and propellers. Use of "Standard Series" tests. In-

troduction to ship motion and control steering and rudders. Concepts of ship design. Computer application to problems. *Prereq.:* Consent of instructor. 3 cr.

802. Thermodynamics II

Energy, phase space, statistics for gases. Condensation, nucleation, fluctuations, potential functions. Thermodynamics of irreversible change. Heats and rates of reactions. Flames. Plasmas. Anisotropic thermodynamics and equilibrium of phases. Low temperatures. High pressures. Practical methods of transformation of energy. *Prereq.:* M. E. 701 or Phys. 608 or Ch. E. 622. 3 cr.

803. Advanced Heat Transfer

The heat flux vector, conduction equation in several variables with solutions by various techniques. Fluid and thermal boundary layer theory. Heat transfer with phase changes. *Prereq.:* M. E. 654. 3 cr.

808. Theoretical Hydrodynamics

The mathematical development of frictionless fluid flow using both tensor notation and various coordinate systems. Conformal mapping, Blausis Theorem, Joukowski Hypothesis, hence application of complex variables to two dimensional flow problems such as flow around airfoils. Schwarz-Christoffel theorem and vortex motion. *Prereq.:* Consent of instructor. 3 cr.

810. Compressible Fluid Flow

Equations of motion for real fluid flow. Theorems in vorticity and circulation. Nonsteady and nonlinear flow problems. Boundary layer effects. Condensation phenomena in high-speed flows. Chemically-reacting flow systems. *Prereq.:* M. E. 750. Math. 651, 652. 3 cr.

812. Advanced Vibrations

Linear and non-linear systems; undamped, damped and forced damped systems; electro-mechanical systems and analogies; tabular methods. *Prereq.:* M. E. 644. 3 cr.

820. Metallurgical Thermodynamics

Entropy and free energy as applied to the solid state. Application of the third law of thermodynamics to order-disorder reactions. The Gibbs-Duhem equation, Hildebrand solubility parameter, and Gibbs Phase rule as applied to homogeneous and heterogeneous solid phase equilibrium. Applications in metal and metal-nonmetal systems. *Prereq.:* Consent of instructor. 3 cr.

825. Mechanics of a Continuous Medium

Analysis of three dimensional stress, strain and velocity strain; Mohr's circles; equilibrium, compatibility, constitutive equations; virtual displacements; stress resultants in beams and plates. *Prereq.:* Consent of instructor. 2 cr.

826. Theory of Elasticity

Two dimensional problems using Airy stress function, torsion, finite difference, energy principles and variational methods. *Prereq.:* M.E. 825. 2 cr.

891. Topics in Solid Mechanics

Content of course may vary from year to year. *Prereq.:* Consent of instructor. 3 cr.

895-896. Graduate Independent Study

Investigation of graduate level problems or areas germane to mechanical engineering. *Prereq.:* Permission of Department. 1-3 cr.

899. Master's Thesis

6-8 cr.

Microbiology

Lawrence W. Slanetz, *Chairman*

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 M.S. degree will be required to complete a thesis and pass an oral examination covering his graduate courses and thesis.

Candidates for the Ph.D. 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. *Prereq.:* Microb. 503. 2 lec.; 1 lab.; 4 cr.

702. Pathogenic and Diagnostic Microbiology

The morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Students will be expected to perform the laboratory procedures for the diagnosis of various infectious diseases. Mr. Metcalf. *Prereq.:* Microb. 503. 2 lec.; 2 lab.; 4 cr. (Formerly 108)

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. *Prereq.:* Microb. 702. 2 lec.; 2 lab.; 4 cr. (Formerly 53)

706. Virology

The animal and plant viruses, including bacteriophages and the rickettsiae; a consideration of techniques for the propagation and recognition of animal viruses; a study of the interactions between virus and host cell and the application to problems of plant or animal infections caused by viruses. Mr. Metcalf. *Prereq.:* Microb. 702. 1 lec.; 3 lab.; 4 cr. (Formerly 160)

795, 796. Problems in Microbiology

Special problems, depending upon the training and desire of the student. Elective only upon consultation. Mr. Slanetz and staff. Credits to be arranged. (Formerly 55, 56)

800. Systematic Bacteriology

Procedures and methods for the classification of bacteria; review of modern systems of classification. Mr. Slanetz. *Prereq.:* One year of Microbiology. 2 lec.; 1 lab.; 3 cr. (Formerly 104)

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; with the generation of activated metabolites during catabolism and the use of these metabolites for the synthesis of macromolecules; with the nongenetic mechanisms directing and regulating cellular metabolism; with the biochemical cytology of the microbial cell; and with evolutionary and ecological relationships among microbial species. Mr. Chesbro. *Prereq.:* Biochemistry (may *not* be taken concurrently) and Microb. 503. 2 lec.; 2 lab.; 4 cr. (Formerly 101)

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. Mr. Hageage. *Prereq.:* Microb. 701. 2 lec.; 2 lab.; 4 cr.

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. Hageage. *Prereq.:* Permission of the instructor. 2 lec.; 2 lab.; 4 cr.

897-898. Microbiology Seminar

Reports and discussions on microbiological literature and recent developments in microbiology. Mr. Slanetz and staff. *Prereq.:* Permission of the instructor. 1 cr. (Formerly 109, 110)

899. Master's Thesis

6-10 cr.

999. Doctoral Research

Music

817 (817). Applied Music for Graduate Credit

(1) Piano; (2) Organ; (3) Violin, Viola; (4) Violincello; (5) Voice; (6) Woodwind; (7) Brass; (8) Percussion. Further development of technique, music interpretation, performance, and emphasis oriented toward the functional use of the instrument in the schoolroom. *Prereq.:* Must exhibit sufficient proficiency to warrant graduate study. Permission of the 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. Mr. Bratton and staff. 1-2 cr. (Formerly 117, 118)

Physics

John A. Lockwood, *Chairman*

For admission to graduate study in Physics the candidate must have satisfactorily completed undergraduate courses in Physics totaling 24 to 30 semester hours. Suitable undergraduate work in mathematics is essential and must include courses in differential equations and advanced calculus. The aim of the program is to give the student broad general training in fundamentals. Entering students will be expected to demonstrate proficiency in undergraduate work equivalent to that of the senior year in Physics at the University of New Hampshire. A placement examination, required of entering graduate students, will be given during the fall registration period.

The following courses are required for the Master's degree: Physics 831, 833, 840, and 841.

Candidates for the Master's degree must select one of the following two options:

a. Completion of 24 course credits plus a thesis for 6 credits, and pass an oral examination on the thesis.

b. Completion of 30 course credits and pass an oral examination on one of the following areas of Physics: electromagnetic theory, classical mechanics, nuclear physics, quantum mechanics, solid-state physics, or thermodynamics and statistical mechanics.

In addition all candidates for a Master's degree must pass a written examination in an area to be selected by the student from the above list. The area chosen must be different from the area of the oral examination in either option (a) or (b). All candidates for the Master's degree are expected to demonstrate proficiency in reading literature in one foreign language: German, French, or Russian. Requirements for the M.S. degree (see page 22) and further details may be obtained from the Department.

The following courses are required for the Ph.D. degree: Physics 831, 833, 835, 839, 840, 841, 842, 861, 863, and 865.

A candidate for the Ph.D. degree will demonstrate that he has a broad basic knowledge of the field of Physics by taking both a preliminary and qualifying examination. The written and the oral examination for the Master's degree will constitute the preliminary examination for the Ph.D. degree. The final qualifying examination will consist of both a written and oral portion based upon the area of specialty selected by the student. The Ph.D. candidate will be expected to demonstrate pro-

ficiency in two languages by passing an examination in German, Russian, or French. The language requirement must be satisfied before taking the final qualifying examination. Requirements for the Ph.D. degree (see page 24) and further details may be obtained from the Department.

All graduate students must register for Physics 897-898 for two years.

607. Physical Optics

Maxwell's equations, the nature of light, interference, diffraction, polarization, and related phenomena. *Prereq.:* Math. 541. 3 cr. (Offered on request.)

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 cr.

701. Introductory Quantum Mechanics

Quantum mechanics with application to atomic physics. *Prereq.:* Phys. 503 and 704. 3 cr.

702. Atomic and Nuclear Physics

Magnetic moments, spin, identical particles, multielection atoms. Collision theory and the nucleus. *Prereq.:* Phys. 701. 3 cr.

831-832. Mathematical Physics

Differential equations of physics, complex variables, orthogonal functions, variational methods, matrices, vector, and tensor analysis. 3 cr.

833-834. Experimental Physics

Modern research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear, atomic, and molecular phenomenon. 1, 2, or 3 cr.

835. Statistical Physics I

A review of thermodynamics and kinetic theory, followed by an introduction to statistical thermodynamics. *Prereq.:* Phys. 831 or permission of the instructor. 3 cr.

836. Statistical Physics II

Basic formulation and application of statistical mechanics to physical problems. *Prereq.:* Phys. 840. 3 cr. (Offered on request.)

837. Mathematical Physics

Formulation and solution of physical problems grouped according to their mathematical properties. *Prereq.:* Phys. 831-832. 3 cr. (Offered on request.)

839. Theoretical Mechanics

Particle mechanics, including the motion of rigid bodies, elasticity, fluid dynamics, and special relativity. Topics in classical mechanics that serve as background for the study of modern physical theories. 3 cr.

840. Quantum Mechanics

Non-relativistic. Basic formulation and application, development of approximation methods, and formal scattering theory. Recommended *prereq.:* Phys. 701 and 839. 3 cr.

841-842. Electromagnetic Theory

The formulation and detailed application of electromagnetic theory to physical problems. *Prereq.:* Phys. 831 or permission of the instructor. (842 offered in request.) 3 cr.

861-862. Advanced Quantum Mechanics

An extension of Phys. 840 and an introduction to relativistic theory. 3 cr.

863-864. Nuclear Physics

Formulation of theory underlying current experiments. *Prereq.:* Phys. 840. 3 cr. (Offered on request.)

865-866. Introduction to Solid State Physics

Development of quantum mechanical theory of solids, transport phenomena, etc. *Prereq.:* Phys. 840 and 835. 3 cr. (Offered on request.)

891, 892. Problems in Theoretical Physics

May be taken more than once. 3 cr. (Offered on request.)

893, 894. Problems in Experimental Physics

May be taken more than once. 3 cr. (Offered on request.)

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. 1-3 cr. May be taken more than once.

897, 898. Seminar

Required of all graduate students. Topics to be selected. No credit.

899. Master's Thesis

6 cr.

999. Doctoral Research

Plant Science

Plant Science is a new department established from the former Department of Horticulture and the crops personnel of the former Department of Agronomy. These departments were consolidated to provide a stronger and broader approach to problems in Plant Science, and several of the courses are now being reorganized for this purpose. The department is well equipped for research in Plant Science.

Students will be expected to have had adequate preparation in the biological and physical sciences before being admitted for graduate work. Students lacking some of these requirements may be admitted, but will be required to complete certain courses without credit before becoming eligible for candidacy.

It is recommended that all graduate students first complete work for the M.S. 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 Ph.D. degree (offered only in Horticulture), in addition to the general requirements, must also demonstrate a reading knowledge of two foreign languages and complete a thesis on original research in the area of Horticulture. One or two minors may be required of Ph.D. candidates in fields closely related to the student's area of specialization.

654. Small Fruits

The culture and economic uses of the strawberry, raspberry, blackberry, blueberry, cranberry, and grape. Each fruit is considered with relation to its history, propagation, planting, pruning, harvesting, marketing, insects and diseases, and domestic uses. Mr. Eggert. 3 cr.

659. Greenhouse Management

Modern methods, including soils, watering, costs of production and marketing, and fundamentals of plant behavior under glass. Mr. Rogers. 2 lec.; 1 lab.; 3 cr.

666. Nursery Management

The development of the nursery business. Factors that influence the location of a nursery, layout of the plant, soil and site, types of plants, pest control, inspection, digging, grading, storage, packing, shipping, and sales. Mr. Eggert. *Prereq.:* Plant Propagation. 1 lec.; 1 lab.; 2 cr.

670. Review of Crop Production

Principles and practices, including the management of soils and the use and response of lime and fertilizers. For personnel in agricultural education and other students with the permission of the advisers. Staff. (Summer session only; offered in 1964.) Two hours daily lec. and lab.; 2 cr.

678. Commercial Greenhouse Crops

The principal crops and an intensive study of their individual culture. Mr. Rogers. *Prereq.:* Greenhouse Management. 2 rec.; 1 lab.; 3 cr.

705. Pasture-Hay Crops and Turf Management

The grasses and legumes used as hay, pasture, and silage, and the methods used in production of high quality forage. Consideration also will be given to turf grasses and management of lawns and turfs. Mr. Higgins. 3 lec.; 1 lab.; 4 cr.

706. Breeding of Field Crops

Principles and methods of breeding of grasses, legumes, and cereal crops. The genetic basis of breeding. Laboratory will consist of genetic problems, crossing and inheritance studies in the greenhouse, and statistical analysis of experimental plot designs. Mr. Dunn. *Prereq.:* Zool. 61. 2 lec.; 1 lab.; 3 cr. (Alternate years; not offered in 1964-65.)

753. Orchard Fruits

Examination of fundamental principles and experimental data and their applications to orchard problems, including the establishment of orchards,

soil management, water and fertilizer requirements, mineral deficiencies, training and pruning, fruit bud formation, pollination and fruit setting, thinning, and winter injury. Mr. Eggert. 3 cr.

763. The Development of the Vegetable Industry

Similarities and differences in management of vegetable production for fresh market, processing, seed, and roadside sales and home use. The significance of the plant processes of photosynthesis, respiration, and translocation to the vegetable grower. Environmental factors of soil, temperature, and moisture as they affect vegetable production. The management and role of plant growing structures, seed testing, variety selection, nutrition, weed control, and irrigation in the home garden and commercial plantings. 2 lec.; 1 lab.; 3 cr.

764. The Commercial Production, Storage, and Marketing of Several Different Vegetable Crops

The management and methods of culture, weed control, insect and disease control, nutrition, irrigation, and marketing of different types of vegetables and in different soils. The use and limitations of specialized equipment and chemicals together with a review of recent experimental work in vegetable production. 2 lec.; 1 lab.; 3 cr.

794. Plant Breeding

Application of the principles of genetics to practical plant breeding. Hybridization, chemical treatments, and selection as means of producing and improving varieties. Mr. Rogers. *Prereq.:* Zool. 61. 2 lec.; 1 lab.; 3 cr.

795, 796. Investigations

Offered in the following: (1) Fruits, Mr. Eggert. (2) Flowers, Mr. Rogers. (3) Vegetables, Mr. Eggert. (4) Ornamentals, Mr. Rogers. (5) Plant Breeding, Mr. Dunn and Mr. Rogers. (6) Field Crop Production, Mr. Higgins. Hours to be arranged. 1-4 cr.

797, 798. Plant Science Seminar

Library and reference work on special phases of horticultural and field crop problems. Practice in consulting literature and in preparation and presentation of reports and abstracts. Required each semester of seniors and graduate students majoring in Plant Science; elective for other qualified students. Staff. 1 cr.

803, 804. Methods of Plant Research

The methods used in laboratory and field in plant investigations including scientilc equipment such as potentiometers, thermocouples, geiger counters, refractometers, spectrophotometers, etc., and their use; project outlines, bibliographies, procedures, interpretation of data and statistical analysis of results. Mr. Eggert and staff. *Prereq.:* Plant Chemistry. 2 cr. (Not offered in 1964-65.)

805. Nutrition of Horticultural Plants

The effect of soil management, fertilizers, mulching materials, and mineral deficiencies on the functioning and performance of horticultural plants. Staff. *Prereq.:* Soils, Plant Chemistry. 2 cr. (Not offered in 1965-66.)

807. Flower Bud Formation, Pollination, and Fruit Setting

The influence of natural environmental factors, soil management, orchard fertilization, and resultant chemical composition of fruit plants on flower bud formation and alternate bearing. The effect of these and genetic factors

on the production of fruit. Staff. *Prereq.:* Plant Chemistry, General Botany, Genetics. 2 lec.; 1 lab.; 3 cr.

809. Inheritance in Horticultural Plants

Advanced problems in plant breeding and inheritance in various horticultural crops. Special emphasis on linkage and polyploids. *Prereq.:* Elementary Genetics and Plant Breeding. Mr. Rogers. 3 cr.

895, 896. Research Techniques

Staff. Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 cr.

899. M. S. Thesis

A thesis study of some phase of Plant Science is usually required of candidates for an advanced degree. 6-10 cr.

999. Ph.D. Thesis

Candidates must complete a thesis on original research in Plant Science.

Poultry Science

(See Animal Sciences)

Psychology

Eugene S. Mills, *Chairman*

The Department has as the major objective of its graduate curriculum the provision of a program which enables the student to advance his scholarly and scientific interests in Psychology. With this as background, the student may wish to undertake further advanced study beyond the Master of Arts degree.

Each student is expected to become competent in the general field of Psychology. In addition, however, the student is encouraged to pursue the interests which develop during his graduate study through independent work. This can be done by registering for Psych. 872, Graduate Practicum, Psych. 881, 882, Reading and Research in Psychology, or Psych. 899, Thesis; or by electing other courses in areas of special interest. The courses taken will be selected by the student and his supervisor on the basis of his interests, academic or professional goals, and courses taken earlier. Departments such as Zoology, Philosophy, Sociology, Economics, or Education may be drawn upon for related course material.

In addition to meeting the requirements for entrance into the Graduate School, students admitted to graduate study in Psychology must have had a minimum of 15 credits in undergradu-

ate courses in Psychology. It is highly desirable that these credits include courses in experimental psychology and elementary statistics.

Upon consultation with the student's supervisor and the prospective director of the thesis, a student may elect to submit a thesis in partial fulfillment of the requirements for the Master's degree. The minimum number of thesis credits will be six. An oral examination is required of all those who write a thesis.

A comprehensive written examination is required of all candidates for the Master of Arts degree. An oral examination may be required of those who do not write a thesis.

605. Mental Hygiene in Teaching

The fundamental needs of human beings, with emphasis on the mental and emotional conflicts of secondary-school students arising from the thwarting of these needs. Ways of recognizing these conflicts by their manifestations and of helping students to resolve them. The mental hazards of the teaching professions. Mr. Jervis. 3 cr. *Not open to students who have completed Psych. 405.* (Formerly 89)

654. Psychopathology

A systematic examination of the more severe behavioral disorders as found in the major forms of the neuroses and psychoses. The ego defense mechanisms and the construct of anxiety are seen as central to the understanding of these disorders. The search for causes, the interpretations of symptoms, and the methods of treatment are considered in detail. Mr. Erickson and Mr. Tempone. *Prereq.:* Psych. 405. 3 cr. (Formerly 54)

663. The Exceptional Child

The gifted, the retarded, the physically handicapped, and the emotionally disturbed, as compared on basic psychological variables such as intellectual functioning, personality dynamics, and adjustment problems. Mr. Lothrop. *Prereq.:* Psych. 400. 3 cr. (Formerly 63)

667. Statistics in Psychology

The problems and methods involved in the statistical treatment of quantitative data in psychology. The computation and interpretation of elementary statistical measures, such as mean, median, standard deviation, and the various methods of correlation. Mr. Duryea. *Prereq.:* Psych. 400. 3 cr. (Formerly 67)

757. Experimental Psychology

Discussion of theory and practices in applying experimental methods to a variety of psychological phenomena. Each student in the class will be responsible for an individual experimental project. Mr. Haslerud, Mr. Erickson and Mr. Duryea. *Prereq.:* Psych. 400. 2 lec.; 1 lab.; 3 cr. (Formerly 57)

758. Psychology of Learning

The experimental support for contemporary theories of learning and their practical implications. Mr. Haslerud. *Prereq.:* Psych. 400. 3 cr. (Formerly 58)

760. Psychology of Motivation

The drives and motives which underlie normal human behavior and the forms of adjustment which arise when motives conflict or encounter external frustration. *Prereq.:* Psych 400. 3 cr. (Formerly 60)

776. Comparative Psychology

Similarities and differences in behavior of infra-human organisms at different phylogenetic levels as aids to understanding how behavior evolved and to the clarification of behavior principles. The historical and biological foundations of such special topics as instinct, consciousness, abnormal behavior, social influence, reasoning, and judgment are surveyed by use of the comparative method. Mr. Duryea. *Prereq.:* Psych. 400. 3 cr. (Formerly 77)

778. Physiological Psychology

The relation between behavior and the structure of the organism. Special attention to the sensory, nervous, and glandular functions as the organic base for motivation, emotion, learning, etc. Mr. Haslerud. *Prereq.:* Psych. 400. 3 cr. (Formerly 78)

782. Social Psychology of Industry

The exploration of social structure and function of industrial organizations. Leadership, role and organization theories, and a critical evaluation of their supporting experimental evidence. Mr. Kay. *Prereq.:* Psych. 400. 3 cr. (Formerly 82)

783. Systematic Psychology

The complex expansion of contemporary psychology as seen in historical perspective. Some of the major antecedents in philosophy, theology, and the physical sciences. The subsequent extensive development of psychology in the United States in the form of complementary schools and systems of thought and research. Mr. Mills. *Prereq.:* Psych. 400. 3 cr. (Formerly 83)

789, (789). Special Topics in Psychology

Taught by a different instructor each year. The course will present advanced material in an area in which the instructor has developed specialized knowledge through research and special study. Students may repeat the course but they may not duplicate areas. Instruction may be given in any one of the following: (1) Clinical, (2) Developmental, (3) Differential, (4) Experimental, (5) Industrial, (6) Learning and Perception, (7) Personality, (8) Physiological, (9) Psychological Evaluation, (10) Psychopathology, (11) Statistics, (12) Systematic. *Prereq.:* 12 semester credits in Psychology and permission of instructor. 3 cr. (Formerly 93)

805-806. Introduction to Counseling and Psychotherapy

Basic psychological issues are examined to identify similarities and differences among schools of psychotherapy. The components of psychotherapy in terms of theory and empirical research. The development of a theoretical construct for counseling. During the second semester the aims of the course are: (a) to develop an appreciation of the complexities of human behavior; (b) to understand better the difficulties in applying theoretical knowledge to the counseling situation. Case material and role playing will be employed to acquaint the student with the interaction which takes place between the counselor and the client. Mr. Jervis. 3 cr. (Formerly 105-106)

808. Case Studies in Counseling

Actual cases are used to reflect a variety of personality theories and counseling techniques. A detailed examination will be made of two individuals in the counseling processes. Other cases will be considered more briefly to explore the interaction of counselor and counselee. Designed to 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 in applying theoretical knowledge to the counseling situation. 3 cr. (Offered only in summer.) (Formerly 108)

814. Advanced Statistics and Experimental Design

Practice in the set-up of parametric and non-parametric statistical problems commonly found in the current literature of experimental, clinical, and industrial psychology. Understanding the assumptions of the various procedures. Mr. Erickson. *Prereq.:* Psych. 667 or its equivalent. 3 cr. (Formerly 114)

823. Individual Testing

To train students in the administration, scoring, and interpretation of individual tests for the appraisal of intelligence. Such instruments as the Wechsler Adult Intelligence Scale, the Stanford-Binet, and the Wechsler Intelligence Scale for Children will be critically analyzed. Students will be required to purchase one set of test materials. Mr. Tempone. *Prereq.:* 15 credits in Psychology or the equivalent in related fields. 1 lec.; 1 lab.; 4 cr. (Formerly 123)

831. Research Methodology

The research process as the attempt to discover answers to meaningful questions through the application of scientific procedures. The relation of theory to research, experimental design, problems of measurement, techniques for data collection, and interpretation of results. Mr. Kay. 3 cr. (Formerly 131)

835. Advanced Psychopathology

A study and review of the experimental and clinical literature with regard to etiological factors involved in the formation of pathological character trends and deviations. An evaluation of clinical theory and classification systems as related to the psychotherapeutic process. Mr. Erickson. *Prereq.:* Psych. 654 and/or permission of the instructor. 3 cr. (Formerly 135)

841. Personality Theory

A critical evaluation of the major theories of personality with particular reference to the theoretical, clinical and experimental contributions to current personality theory. 3 cr. (Formerly 141)

850. Advanced Social Psychology of Industry

An exploration of the methods and principles involved in studying man within the social structure of industry. *Prereq.:* Psych. 782 or by permission of the instructor. Mr. Kay. 3 cr. (Formerly 150)

862. Psychology of Perception

The experiments and theories dealing with the fundamental stimulus situation in the internal and external environment. This knowledge of how the organism sees and interprets his world has many applications, e.g., social stimulation, self-regard, and a basis for the projective tests. Mr. Haslerud. 3 cr. (Formerly 162)

864. Introduction to the Rorschach Test

The administration, scoring, and preliminary interpretation of the Rorschach Inkblot Test. Students will be required to purchase the test materials and to administer and score a minimum of twenty Rorschachs. Klopfer's scoring system will be used for the determinants and Beck's for location. Miss Riggs. 1 lec.; 1 lab.; 4 cr. (Formerly 164)

872. Graduate Practicum

Practical work experience in clinical or industrial psychology. Students will be assigned to institutions or industries and serve under experienced personnel and under supervision of departmental instructors. *Prereq.:* Open to a limited number of graduate students who secure permission of the departmental supervisor. Credits to be arranged up to a maximum of 6. (Formerly 172)

895, 896. Reading and Research in Psychology

A student may undertake a course of readings in psychological journals and books or work on an experiment or other research on some topic acceptable to both student and instructor. The projects are directed by individual conferences. Staff. 3 cr. (Formerly 181, 182)

899. Master's Thesis

Open to students who are especially interested in doing independent original research. 6 cr.

Resource Economics

William F. Henry, *Chairman*

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.

604. Farm Management Analysis

Principles of managing farms for maximum income, including methods of making management decisions; enterprise selection and resource combination; adjustment to prices; management of land, labor, and equipment; obtaining capital; farm planning; records and analysis of performance. The principles are applied to several kinds of farms through examples, laboratory problems, and farm visits. Mr. Andrews. 3 lec.; 1 lab.; 4 cr.

697-698. Seminar in Resource Economics

Presentation and discussion of reports on economic theory and current economic topics with departmental staff. Prereq.: Junior standing. May be repeated. 1 cr.

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. *Prereq.:* Eco. 1. 3 cr.

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. *Prereq.:* 3 hours of statistics. Mr. Drew. 3 cr.

711. Public Policy for Agriculture

Problems which are the basis for government and private policies in the production and marketing of agricultural products. Prices, production controls, marketing agreements, conservation, and farm credit are appraised relative to the objectives of agriculture and the concept of general welfare. Mr. Drew. 3 cr.

715. Linear Programming

Setting up and solving problems by the simplex and distribution methods, variations in linear programming problems, solving input-output and game theory problems, and parametric programming. Least cost combinations, maximum profit combinations, transportation and spatial equilibrium, and intersector flows. *Prereq.:* Math. 7 or permission of instructor. Mr. Andrews. 3 cr.

795-796. Investigations in Resource Economics

Special assignments in readings and problems to satisfy the student's needs. Mr. Andrews, Mr. Bowring, Mr. Drew, Mr. Grinnell, and Mr. Henry. 1-3 cr.

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 cr.

807. Statistical Analysis

Statistical measurement and research tools for use in the physical and social sciences. Regression, analysis of variance, factorial, analysis, covariance, time series, sampling and experimental design. Mr. Bowring. 3 cr.

809. Agricultural Economics

Analysis of supply, demand, and price relationships. Appraisal of the economic theory relevant to decision-making in food production, marketing, and consumption, and on the competitive structure of the food industry. Mr. Henry. 3 cr.

895-896. Investigations in Resource Economics

With the advice and consent of the instructor, a student, prepared by training and experience to do independent work, may register for a reading and research course. The student will undertake assigned problems and

readings under guidance of the instructor. Mr. Andrews, Mr. Bowring, Mr. Drew, Mr. Grinnell, and Mr. Henry. 1-3 cr.

897-898. Seminar in Agricultural and Resource Policy

Presentation and discussion of reports on public policy issues associated with agriculture and resource development. Departmental staff. May be repeated. 1 cr.

899. Thesis

To be arranged. 6-10 cr.

Social Science

893, 894. Internship in College Teaching

Limited to Ford Foundation Scholars. Each student will be responsible for teaching one section of introductory courses in his major department in the Social Science division. This teaching will be done under faculty supervision. In addition, students will attend bi-weekly seminars designed to acquaint them with the various aspects of the college teaching profession. 3 cr.

Sociology

Richard S. Dewey, *Chairman*

Admission to graduate status in the Department of Sociology is granted to the student who meets the entrance requirements of the Graduate School, and who has passed a comprehensive examination in sociology which is prepared by the members of the Department. This examination may be taken, under appropriate supervision, at a time and place which is convenient to the candidate.

In addition to having fulfilled the general requirements, the successful candidate for the Master of Arts degree in Sociology will have completed a thesis written in one of the following fields: criminology, cultural anthropology, mass communications, minority group relations, population, rural sociology, social movements, social stratification, social theory, and urban sociology. It is expected that competence in both method and theory will be demonstrated in the thesis. No more than nine semester hours' credit in other departments will be accepted. No general oral or written examination is required.

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 cr. (Formerly 75)

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 Social Service Curriculum may be admitted by permission of instructor. *Prereq.:* Soc. 701. 3 cr.

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 cr. (Formerly 71)

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 19th 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 the instructor. 3 cr. (Formerly 185, 186)

740. Culture Change

The study of various types of society leading to the development of a theory of culture change. Descriptive studies of institutional as well as theoretic materials selected from the writing of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. *Prereq.:* Soc. 400 or consent of instructor. 3 cr. (Formerly 54)

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. *Prereq.:* Soc. 400. 3 cr. (Not offered in 1964-65.) (Formerly 62)

745. Social Stratification

Nature, functions, patterns, and effects of social stratification. Social mobility. The social class system in the United States. *Prereq.:* Soc. 400. 3 cr. (Formerly 57)

760. Crime Control

The theory and practice of preventing crime and delinquency and of rehabilitating the criminal and the delinquent. There will be a number of lectures by, and discussions with, various penologists. A seminar course limited to 15 students. *Prereq.:* Soc. 703. Permission of instructor. 3 cr. (Formerly 88)

815. Criminology Internship

A four-month, three-quarter time, paid internship in a correctional institution. Consists of various types of routine correctional work and of the execution of small research projects as requested by the director of the prison or reformatory. Opportunity for thesis research in this setting is available. Required for Master of Arts in Sociology with specialization in Criminology. No credit. (Formerly 133)

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. *Prereq.:* 12 hours of Sociology and consent of instructor. Hours and credit to be arranged. (Formerly 181, 182)

897, 898. Special Topics Seminar

Under the direction of members of the Department on the basis of rotation and interest, seminars are offered in those fields listed under Soc. 895, 896. *Prereq.:* Consent of instructor. 3 cr. (Formerly 151, 152)

899. Master's Thesis

Usually 6 cr., but up to 10 cr. when the problem warrants.

Soil and Water Science

Before students are admitted to graduate study in Soil and Water Science they must have had basic courses in soils as well as 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 thesis.

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. *Prereq.:* Biochem. 501 or Chem. 517 or their equivalent. 1 lec.; 2 lab.; 3 cr. (Alternate years; offered in 1964-65.)

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. *Prereq.:* Chem. 401-402 or Chem. 403-404 or their equivalent. 3 lec.; 3 cr. (Alternate years; offered in 1964-65.)

703. Soil and Water Engineering

The hydrologic, soil, vegetal, and stream flow factors involved in the design and operation of erosion control structures, drainage systems, and irrigation systems. Mr. Byers. 2 lec.; 1 lab.; 3 cr.

704. Soil Classification and Mapping

The genesis, morphology, classification, and mapping of soils. Mr. Peterson. *Prereq.:* Soils 501 and Geol. 401 or 407 or permission of instructor. 2 lec.; 1 lab.; 3cr. (Alternate years; not offered in 1964-65.)

797-798. Soil and Water Science Seminar

Library and reference work on special phases of soil and crop problems. Practice in consulting literature and in preparation and presentation of reports and abstracts. Required each semester of seniors and graduate stu-

dents majoring in Agronomy; elective for other qualified students. Staff. 1 cr.

795-796. Investigations

Offered in the following: a. Physics and Chemistry of Soils, Mr. Prince; b. Soil-Plant Relationships, Mr. Peterson. Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

802. Advanced Soil Chemistry

Lectures, discussions, 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. Mr. Prince. *Prereq.:* Soils 702 and Chem. 517 or permission of instructor. (At least one semester of physical chemistry recommended.) 3 cr.

895-896. Research Techniques

Offered in: a. Soil-Plant Relationships, Mr. Peterson. 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 cr.

Zoology

Paul A. Wright, *Chairman*

To be admitted to graduate study in Zoology, a student must have completed basic undergraduate preparation in some field of the biological sciences, with at least two years' work in Zoology. Suitable training in botany, chemistry, mathematics, and physics is also necessary. Students lacking these requirements may 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 preparation in the field and their graduate and undergraduate courses in the biological sciences. With the permission of the Department Chairman and the prospective Supervisor of the Thesis, a student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree.

Students who apply for advancement to candidacy for the Ph.D. degree 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 an oral qualifying examination.

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. *Prereq.:* Zool. 412 or equivalent. 3 cr. (Formerly 71)

704. Comparative Endocrinology

The various endocrine organs, vertebrate and invertebrate, with particular emphasis on endocrines which relate to physiology of reproduction. Mr. Wright. *Prereq.:* Permission. 3 cr. (Formerly 112e)

(706), 706. Genetics

The physical basis of inheritance, expression, and interaction of the hereditary units, linkage, and variation. The application of Mendelian principles to plant and animal breeding. Mrs. Richardson. *Prereq.:* Zool. 412 or equivalent. 3 lec.; 1 lab.; 4 cr. (Formerly 61)

711, 712. Natural History and Taxonomy of the Vertebrates

The various classes of vertebrates; their habits, habitats, and life histories, with special reference to those occurring in eastern North America. Zool. 711 will include the fishes, amphibia, and reptiles. Zool. 712 will cover the mammals and birds. Mr. Sawyer. *Prereq.:* General Zoology and Zool. 508. 2 rec.; 2 labs.; 4 cr. (Formerly 77, 78)

(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. Mr. Moore. *Prereq.:* General Zoology. 1 lec.; 3 labs.; 4 cr. (Also offered in Summer Session annually.) (Formerly 68)

721. Parasitology

An introductory course on some of the more important parasites causing diseases of man and animals. Living materials will be used as far as possible. Mr. Bullock. *Prereq.:* One year of Zoology. 2 lec.; 2 lab.; 4 cr. (Formerly 51)

725. General Physiology

The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction. Mr. Milne. *Prereq.:* One year of Zoology and Organic Chemistry. 3 lec.; 1 lab.; 4 cr. (Formerly 59)

729. Vertebrate Morphogenesis

A comparative study of the organ systems of the vertebrate body and their embryonic development. Mr. Staugaard. *Prereq.:* Zool. 507-508 or equivalent or permission. 3 lec.; 2 lab.; 5 cr. (Formerly 65)

730. Elements of Histology

The microscopic anatomy of principal tissues and organs of vertebrates with an introduction to general histological technique. Mr. Bullock. *Prereq.:* Zool. 508 or equivalent or permission. 2 lec.; 2 lab.; 4 cr. (Formerly 66)

736. Advanced Genetics

The recent advances in genetics and cytogenetics. Staff. *Prereq.:* Zool. 706. 2 lec.; 2 lab.; 4 cr. (Formerly 62)

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. *Prereq.:* Permission of the 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. Experimental Embryology, 6. Genetics, 7. Histology, 8. History of Zoology, 9. Invertebrate Zoology, 10. Molecular Biology, 11, Physiology, 12. Vertebrate Embryology, 13. Vertebrate Zoology, 14. Zoogeography, 15. Zoological Techniques.

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. *Prereq.:* Zool. 701; courses in physics, chemistry, invertebrate and vertebrate zoology, geology, algology, and aquatic entomology are desirable. 2 lec.; 2 lab.; 4 cr. (Offered in Summer, 1964; omitted during academic year, 1964-65; alternates with Zool. 803.) (Formerly 72b)

803. Marine Ecology

The marine environment and its biota, based on application of general ecological principles. Field work will be largely confined to the shore. Students should be prepared to work in 2 to 3 feet of cold water. Field trips may be scheduled for early morning, late afternoon, or on weekends. Travel will be at students' expense and should not exceed $30 for the course. Mr. Swan and Staff. *Prereq.:* Zool. 701 or equivalent. 2 lec.; 2 lab.; 4 cr. (Offered Semester I, 1964-65, and Summer, 1965; alternates with Zool. 801.) (Formerly 72c)

818. Histochemistry

The principles and techniques for localization of inorganic and organic substances in tissue sections. Mr. Bullock. *Prereq.:* Zool. 730 and a knowledge of microtechnical procedures. 2 lec.; 2 lab.; 4 cr. (Not offered in 1964-65.) (Formerly 66)

820, 821. Invertebrate Zoology

The morphology, phylogeny and natural history of the major invertebrate groups. Staff. *Prereq.:* General Zoology. Zool. 715 desirable. 2 rec.; 2 lab.; 4 cr. (Zool. 820 not offered in 1964-65.) (Formerly 55, 56)

(822). Protozoology

The general biology of free-living and parasitic Protozoa with particular emphasis on morphology, natural history, and economic importance. *Prereq.:* Zool. 722 or 820 or permission. Mr. Borror and Mr. Bullock. 2 lec.; 2 lab.; 4 cr. (Offered alternate years; offered in 1964-65; also offered Summer, 1964.)

824. Helminthology

The basic principles of parasitism as exhibited by various groups of parasitic worms. Emphasis on life cycles, physiology, and host-parasite relationships. Mr. Bullock. *Prereq.:* Zool. 721. 2 lec.; 2 lab.; 4 cr. (Offered alternate years; offered in 1964-65.) (Formerly 151)

826. Comparative Physiology

The means whereby animals, both vertebrate and invertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Milne. *Prereq.:* Zool. 725. 3 lec.; 1 lab.; 4 cr. (Formerly 57, 157)

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. Staff. *Prereq.:* Zool. 820, 821. 2 rec.; 2 lab.; 4 cr. (Not offered in academic year, 1964-65; offered in Summer, 1965.) (Formerly 176)

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. *Prereq.:* Permission of Department Chairman and Staff concerned. 1-6 credits. Sections of this course with their subject matter fields are: 1. Bibliographic Methods, 2. Ecology, 3. Endocrinology, 4. Evolution, 5. Experimental Embryology, 6. Genetics, 7. Histology, 8. History of Zoology, 9. Invertebrate Zoology, 10. Molecular Biology, 11. Physiology, 12. Vertebrate Embryology, 13. Vertebrate Zoology, 14. Zoogeography, 15. Zoological Techniques, 16. Helminthology, 17. Histochemistry, 18. Invertebrate Embryology, 19. Protozoology, 20. Systematics.

899. Master's Thesis

Open to students who wish to do independent original research. *Prereq.:* Permission of the Department Chairman and Prospective Supervisor. 1-6 cr.

999. Doctoral Research

Open to students who have declared their intention of proceeding to candidacy for the Ph.D. degree.