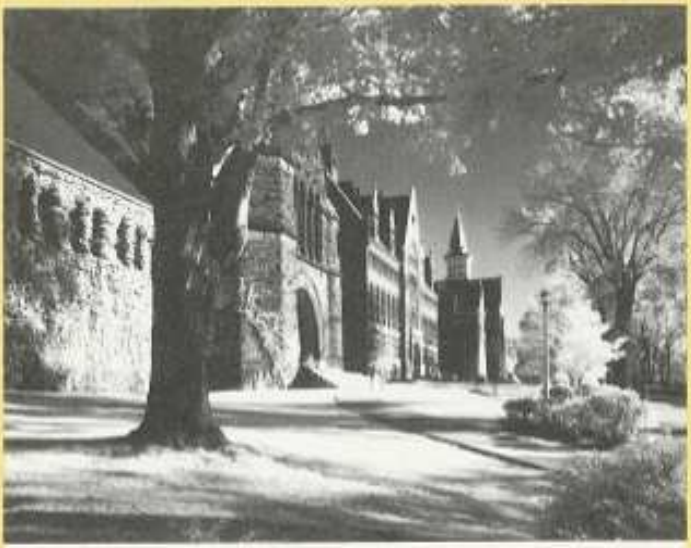
BULLETIN OF
THE UNIVERSITY OF VERMONT



the GRADUATE COLLEGE

JANUARY / 1966

Correspondence:

All correspondence concerning applications and admission to the Graduate College should be addressed to the Office of the Graduate College.

Requests for transcripts of work done at The University of Vermont should be addressed to the Registrar.

Requests for the Summer Session Bulletin and other information regarding Summer Session offerings should be addressed to the Director of the Summer Session.

BULLETIN OF THE UNIVERSITY OF VERMONT
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Bulletin of the University of Vermont

THE GRADUATE COLLEGE

CATALOGUE / 1965-1966

ANNOUNCEMENTS / 1966-1967

BURLINGTON, VERMONT

Academic Calendar

- SPRING SEMESTER *1966*

January 18	Registration 8:30 a.m. to 3:00 p.m.
January 19	Classes begin
February 25-26	Kake Walk Recess
March 15	Deadline for applications for Graduate Fellowships for *1966-67*
March 21-25	Enrollment
March 28-April 3	Spring recess
April 4	Classes resume
April 4-15	Enrollment
May 9-17	Course examinations
May 16	Deadline for oral defenses of theses
May 22	Commencement; academic year terminates

- SUMMER SESSION *1966*

June 20-August 12	Eight Weeks Session (Registration—June 20)
July 5-August 16	Six Weeks Session (Registration—July 5)

- FALL SEMESTER *1966*

September 6	Registration 8:30 a.m. to 3:00 p.m.
September 7	Classes begin
October 31-November 18	Enrollment
November 24-26	Thanksgiving Recess
December 12-20	Course examinations

- SPRING SEMESTER *1967*

January 17	Registration 8:30 a.m. to 3:00 p.m.
January 18	Classes begin
February 17-18	Kake Walk Recess
March 15	Deadline for applications for Graduate Fellowships for *1967-68*
March 20-24	Enrollment
March 27-April 2	Spring recess
April 3	Classes resume
April 3-14	Enrollment
May 8-16	Course examinations
May 15	Deadline for oral defenses of theses
May 21	Commencement; academic year terminates

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The University of Vermont

The University of Vermont is located at Burlington, Vermont, situated on the shores of Lake Champlain. Burlington, the largest city in the State, with a population of 35,000, is 95 miles from Montreal, 230 miles from Boston, and 300 miles from New York City. Burlington has daily bus, train and air service.

The University was founded in 1791, taking its place among the handful of colleges founded in this country in the eighteenth century for the higher education of young colonials and Americans of the first post-revolutionary generation. The University was the fifth New England college chartered, the second established by a state to grant the bachelor's degree, and the twentieth in the nation to do so.

Though it has enjoyed a long tradition which has seen it receive substantial private support, University development has been closely indentified with that of the State since 1791, when Vermont's founding General Assembly granted a charter to the University and set aside about 29,000 acres throughout the State with the intent that rents from this land would support the new educational institution.

That same Vermont General Assembly established that the by-laws of the University should give no preference to any religious sect or denomination or discriminate against any, making the University of Vermont the first in this country and possibly the first in history to go on public record as supporting freedom of religion upon its campus.

The University consists of the College of Arts and Sciences, the College of Agriculture and Home Economics, the College of Technology, the College of Education and Nursing, the College of Medicine, the Graduate College, and the two-year School of Dental Hygiene.

Many academic departments of the University have a long history of providing formal graduate study for well-qualified candidates. The Graduate College was formally established in 1952, and since that time has served to provide graduate study opportunities in academic fields in which University resources have made sound graduate programs possible. In recent years nine doctoral programs have been inaugurated and more are being planned. The Graduate College administers all degree programs beyond the bachelor's degree, with the exception of the program leading to the degree of doctor of medicine.

Scholarship aid, fellowships, assistantships and special loan programs are available in increasing numbers for graduate study for the student who has achieved a good academic record in his undergraduate program.

Officers of Administration

SHANNON McCUNE, Ph.D.	*President*
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RAYMOND VIRGIL PHILLIPS, Ph.D.	*Dean of Summer Session and Evening Division*
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Ph.D. (Yale)

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Ph.D. (Pennsylvania)

Degree Programs Offered

The Graduate College offers fifty-five different programs leading to the Master's degree and nine programs leading to the degree of Doctor of Philosophy. Each student is expected to be familiar with the general regulations and procedures of the Graduate College, and with the specific degree requirements in his chosen field of study.

- *MASTER OF EDUCATION*

Programs are designed to prepare qualified candidates for school positions in guidance, supervision, and administration, or to give classroom teachers a more complete understanding of professional education as applied to teaching and to membership in the profession. Programs are planned on an individual basis and may include courses in areas outside professional education.

- *MASTER OF ARTS IN TEACHING*

This degree is appropriate for teachers who are interested primarily in increasing their knowledge of their subject matter fields and thereby the effectiveness of their classroom instruction. Programs are offered in the following fields:

Agriculture
Botany
Chemistry
English
French
Geology
German
Greek
History
Home Economics
Latin
Mathematics
Music
Physics
Zoology

- *MASTER OF EXTENSION EDUCATION*

This degree is designed to meet the needs of county agricultural agents, home demonstration agents, 4-H Club agents, extension specialists, professional cooperative and agricultural business leaders.

- *MASTER OF SCIENCE*

Programs are offered in the following fields:

Agricultural Biochemistry
Agricultural Economics
Anatomy
Animal and Dairy Science
Animal Pathology
Biochemistry
Botany
Chemistry
Civil Engineering
Commerce
Electrical Biophysics
Electrical Engineering
Forestry
Geology
Home Economics
Mechanical Engineering
Medical Electronics
Medical Microbiology
Microbiology
Pathology
Pharmacology
Physics
Physiology and Biophysics
Plant and Soil Science
Poultry Science
Speech Pathology
Zoology

- *MASTER OF ARTS*

Programs are offered in the following fields:

Economics
English
French
German
Greek
History
Latin
Mathematics
Music
Political Science
Psychology

- *DOCTOR OF PHILOSOPHY*

Doctoral programs are offered in the fields of Biochemistry, Botany, Chemistry, Microbiology, Pharmacology, Physics, Physiology and Biophysics, Psychology, and Zoology. Programs leading to the doctoral degree may be offered in additional departments in the near future.

Fifth Year Certificate in Education

A special fifth year program culminating in a certificate of advanced study is offered by the Department of Education for students who wish to work beyond the bachelor's degree. It is especially designed to meet the needs of teachers who are developing new teaching fields, for advanced students who are meeting requirements for state certification, and for experienced teachers who desire flexibility in choice of courses at both graduate and undergraduate levels. Information about the certificate program may be obtained by contacting the Dean of the College of Education and Nursing.

Regulations of the Graduate College

• *ADMISSION*

Students who, prior to the date of their first enrollment, will hold a baccalaureate degree or will have completed work equivalent to that required for a baccalaureate, and whose undergraduate records indicate that they are capable of successful study at the graduate level may apply for admission to the Graduate College. Graduates of unaccredited institutions must support their applications with satisfactory scores on the Graduate Record Examinations. Foreign students, see special instructions on p. 15.

Admission is limited to students who intend to become candidates for advanced degrees, other than Doctor of Medicine, and students whose enrollment will consist of courses to be taken for graduate credit. Students who hold bachelors' degrees but whose entire enrollment will be in undergraduate courses should seek admission as non-matriculated students in the appropriate undergraduate college.

Only applicants who desire to work along lines in which the University offers graduate programs will be admitted to the Graduate College. Students in the Graduate College therefore fall into three categories: (1) duly admitted students accepted to candidacy, (2) degree candidates at other institutions who study at The University of Vermont for transfer of credit, (3) duly admitted students not yet accepted to candidacy.

Students seeking admission to the Graduate College to pursue an advanced degree must make application on an official form which can be obtained from the Office of the Graduate College. All applications must be supported by official transcripts from each college or university attended and by three letters of recommendation from persons qualified to assess the applicant's capacity for graduate work. For submission of necessary test scores, see Aptitude and Achievement Tests, p. 15. *All applications for admission must be accompanied by a $10.00 application fee.*

The deadline for applications for admission in the fall semester is May 15. It is not always possible to admit additional students at mid-year in all departments. Such applications should be initiated well in advance of the date study is to begin. Students who wish to be con-

sidered for fellowships as well as admission should complete the appropriate section on the application form. Such applications, with supporting materials, must be filed by March 15 of the academic year preceding that for which the application is made.

Admission to the Graduate College does not mean that a student is automatically accepted as a candidate for an advanced degree.

Foreign Students Applications from foreign students, other than those of the United Kingdom, Canada, Australia, and New Zealand, and those studying in the United States at the time of application, will be accepted only through the Institute of International Education.

Foreign students should make application for sponsorship through the Institute a year in advance. For information write to Institute of International Education, 809 United Nations Plaza, New York, N. Y. 10017.

Aptitude and Achievement Tests Applicants for admission to graduate programs in some departments must submit scores on the Graduate Record Examination and the Miller Analogies Test (see under department). Information on the Miller Analogies Test may be obtained from the Testing Office, University of Vermont or from any college testing office. Information on the Graduate Record Examination may be obtained from the Educational Testing Service, Box 592, Princeton, New Jersey.

Deposit A deposit of $35 is required of each applicant upon notification of admission into the Graduate College. The deposit will cover the advanced degree fee of $25 (cf. p. 26, Fees). Any residue from this deposit will be returned to the student upon graduation or upon withdrawal from the college.

Credentials submitted by the student, such as transcripts and letters of recommendation become the property of the Graduate College and may not be returned.

• *ENROLLMENT*

Every student is required to enroll and register at the time and in the manner designated by the Registrar. All charges for the ensuing semester must be paid, or otherwise provided for, before registration is completed.

Changes in Enrollment Any changes in enrollment must be authorized by the Dean of the Graduate College. A student may add a course only during the first week of classes, but may drop a course without academic penalty during the first three weeks of classes. Change of enrollment forms are obtained from the Office of the Dean of the Graduate College.

Completion of Thesis A student who has completed all credits required in his degree program, but is in residence for the purpose of completing his thesis, should enroll for "Completion of Thesis" (cf. p. 25, Fees).

Withdrawal If it is necessary for a student to withdraw from his enrollment he must request permission at that time from the Dean of the Graduate College in writing, stating the reason for his withdrawal.

Auditing Courses With the approval of the Dean and the instructor concerned, a student paying full tuition may audit courses without charge. Auditors have no claim on the time or service of the instructor and no entry will be made on the permanent record. Under no circumstances will credit be allowed for courses audited.

Summer Study Information regarding graduate course offerings may be obtained from the Summer Session Office. All students taking courses for graduate credit during the summer must request permission to do so by completion of the special request form. Enrollment in such courses for graduate credit does not imply admission to the Graduate College.

Dismissal A graduate student whose work or deportment is unsatisfactory may be requested at any time by the Dean or the department concerned to withdraw from the Graduate College.

• *GENERAL REQUIREMENTS*

Acceptance to Candidacy A student will be accepted to candidacy upon approval of both the Dean and the department or departments concerned. Acceptance to candidacy can be granted only in cases where a student has fully met all undergraduate prerequisites for the courses that are required in his graduate degree program. A year of graduate study in residence at The University of Vermont is a prerequisite for acceptance to candidacy for the doctoral degree; applicants for the master's degree may be accepted to candidacy concurrently with admission.

Minimum Residence Requirements Each candidate for the master's degree must satisfactorily complete at least twenty hours of graduate

credit while in residence on The University of Vermont campus, either in the regular academic year or in summer sessions or at the off-campus centers established at Lyndon and Castleton. Each candidate for the doctor's degree must satisfactorily complete at least thirty hours of graduate credit in residence on The University of Vermont campus; ordinarily a minimum total of fifty hours in residence will be required.

Teaching Requirement Each degree candidate must acquire appropriate teaching experience in his chosen field prior to the award of his degree. The nature and the amount of this teaching, for which no academic credit is allowed by the Graduate College, will be determined by the department concerned.

Graduate Credit Courses numbered 400 and above are open to doctoral students only. Courses numbered 300 to 399 are open to graduate students only. Courses numbered between 200 and 299 are also offered for graduate credit, and, if taken by graduate students, must be taken for graduate credit.

Courses numbered between 100 and 199 are normally courses for undergraduates. No degree program can include more than ten hours graduate credit for courses numbered between 100 and 199 and most programs include none. Graduate credit can be allowed for some courses so numbered only (1) if the student has already been accepted to candidacy, and (2) has obtained *in advance* the approval of his department and the Dean for inclusion of this particular course in his degree program.

Under no circumstances will graduate credit be allowed for a course numbered below 100.

Grade Requirements Letter grades are used to indicate levels of performance in courses as follows: *A*, excellent; *B*, good; *C*, fair; *F*, failure. Designations of *S*, satisfactory and *U*, unsatisfactory are used to indicate levels of performance for credits received in Thesis Research and Seminar.

A candidate for a graduate degree must complete his program with a minimum overall quality point average of 3.0. For the purpose of determining a quality point average, 4 points are allowed for each credit hour of *A*, 3 points for each credit hour of *B*, 2 points for each credit hour of *C*, and 0 points for each credit hour of *F*. A course may be repeated for credit only when failed and only once. Only the second grade is then considered.

A student may be dismissed from the Graduate College if he receives more than two grades below a *B*, if he receives a grade of *F* in more than one course, or if he receives the designation of *U* in Thesis Research or Seminar.

The designation "*Inc*" is used to indicate that the work of the course is incomplete for a reason approved by the Dean and must be completed within a specified time.

Maximum Time Limits A program leading to the master's degree must be completed within a span of three years if it is pursued on a full-time basis during the regular academic year; if it is pursued on a part-time basis or in summer sessions, it may be completed within a span of seven years. A doctoral program must be completed within a span of nine years. Only in special cases will credits earned outside these time limits be re-evaluated and reinstated; requests for such re-evaluation must be addressed to the Dean and must be accompanied by a full statement of the extenuating circumstances. This time limit applies both to study at The University of Vermont and to courses presented for transfer of credit. Individual departments may set deadlines within these time limits.

Transfer of Credit A maximum of eight hours credit in the case of master's candidates and twenty-five hours in the case of doctoral candidates may be accepted in transfer for appropriate courses completed in residence in other institutions. Such courses must have been taken in a fully accredited college or university which offers graduate study and must be acceptable at that institution in partial fulfillment of its requirements for an advanced degree. Credit cannot be transferred for (1) courses which would not, if taken at The University of Vermont, receive graduate credit, (2) courses in which a grade lower than 80 (B—) was received, (3) extension courses, (4) correspondence courses, (5) courses which are inappropriate for inclusion in any degree program offered by the Graduate College, (6) courses which were taken more than seven years prior to the completion of a degree program, (7) thesis credits received at another university. No transfer of credit is possible prior to a student's acceptance to candidacy.

Extension Courses Not more than eight semester hours of credit toward the master's degree may be earned by taking extension courses offered by The University of Vermont. A maximum of three hours of graduate credit per semester is permissible for master's candidates who

are full-time teachers in public schools. No credit for extension courses is allowable in a doctoral program.

Conferring of Degrees Degrees are conferred at the Commencement at the end of the academic year. If a student has completed all the requirements for a degree, he will be issued a letter certifying that he has completed his graduate degree program and that the degree will be conferred at the next Commencement. A candidate must be present at the Commencement unless he has been excused in advance by the Dean.

• *REQUIREMENTS FOR MASTER'S DEGREE*

All master's degree programs require a minimum of thirty semester hours of graduate credit. In programs that require a thesis, the number of credit hours to be earned in thesis research may vary between six (minimum) and fifteen (maximum); these credits are included in the minimum of thirty required for the degree.

MASTER OF EDUCATION

Before acceptance to candidacy for the degree of Master of Education, the student must present a satisfactory score in the Miller Analogies Test, and must demonstrate satisfactory proficiency in written composition. Before the degree is awarded, the candidate must have completed one year of successful teaching experience or other educational service.

The graduate program of each student admitted to candidacy for the degree of Master of Education is planned and supervised by an individual committee, which includes *ex-officio* the Deans of the Graduate College and the College of Education. A graduate program is planned in view of a student's undergraduate curriculum and in the light of his aims and purposes in pursuing the master's degree, and in such a way that its subject matter will be concentrated as far as possible within a general area of study. Each program must include either thirty semester hours of approved course work or twenty-four hours earned in courses and six hours in thesis research. If a student's preparation is inadequate for him to begin study at the graduate level in certain aspects of his program, additional undergraduate courses will be required.

In order to insure effective planning of a graduate program for the degree of Master of Education, not more than twelve hours credit (fourteen if the maximum eight hours of transfer credit is offered) will be accepted in partial fulfillment of degree requirements for courses taken

prior to acceptance to candidacy. A prospective candidate should therefore make application for acceptance to candidacy before his first semester of residence, or, if he has been a student in Summer Session, prior to his second summer in residence. Candidates must expect to earn on The University of Vermont campus a part of the credit to be applied to a graduate degree. In most cases candidates who are in residence during the regular academic year must also attend one or two summer sessions in order to have a suitable selection of available courses.

Examinations

a. A written comprehensive examination (three hour minimum) in the field of Education.
b. A comprehensive oral examination (one hour minimum) in the field of Education.

Success in the written examination is prerequisite to taking the oral examination. One re-examination only is permitted for any final comprehensive examination.

MASTER OF ARTS IN TEACHING

The program leading to the degree of Master of Arts in Teaching is designed primarily for teachers with the purpose of enhancing their teaching ability and strengthening their background in their subject matter field.

A minimum of thirty semester hours is required in courses numbered above 200, of which not less than six semester hours shall be in Education taken at The University of Vermont. No thesis is allowable in this degree program; a student must complete at least twenty hours, and usually twenty-four, in a single department offering courses for graduate credit or in any acceptable combination of such departments. In order to be accepted to candidacy for this degree, a student must have completed an undergraduate major within the area of his specialization, have submitted satisfactory scores on the Miller Analogies Test, and be acceptable to the department or departments concerned.

In his undergraduate program, a candidate is expected to have completed the necessary courses in education to meet minimum requirements for a teaching certificate. If candidates have not qualified for teaching certification, they cannot expect to complete the degree in one academic year. To qualify for the degree of Master of Arts in Teaching, the candidate must present at least eighteen semester hours in education in his combined undergraduate and graduate program.

Examinations

a. A written comprehensive examination (two hour minimum) in the field of Education.
b. A written comprehensive examination (two hour minimum) or a comprehensive oral examination (one hour minimum) in the field of specialization. The choice between written and oral examination is to be determined by the department after consultation with the candidate. All examinations are taken on the University campus in Burlington.

One re-examination only is permitted for any final comprehensive examination.

MASTER OF EXTENSION EDUCATION

A minimum of thirty hours is required in courses numbered above 200. Nine semester hours are required as follows: Political Science 241, Philosophy 214, Economics 204 (courses equivalent to Political Science 241 and Economics 204 may be substituted); a minimum of twelve semester hours of course credit in Agriculture and/or Home Economics or related basic courses; and a minimum of six semester hours of course credit in Agricultural Education, Extension Education, and/or Home Economics Education.

The candidate must have completed one year of successful professional experience before the degree is granted.

The candidate is at liberty to select the manner in which he or she will complete the requirements for the degree from the alternatives of: (1) a combination of three-week and six week summer sessions, (2) a combination of summer session and extension course offerings in the State, (3) full-time residence on the campus, and (4) a combination of one term of residence and summer sessions.

Examinations

a. A written comprehensive examination (two hour minimum) in the technical and social science areas.
b. A comprehensive oral examination (one hour minimum) in the field of specialization.

Success in the written examination is prerequisite to taking the oral examination. One re-examination only is permitted for any final comprehensive examination.

MASTER OF ARTS AND MASTER OF SCIENCE

Field of Specialization At least twenty hours of graduate credit, including credit for the thesis and research leading to the thesis, must be earned in the field of specialization. All course credits included in these twenty hours must have been earned in courses which are numbered above 200.

Related Study A graduate program may include advanced courses outside the field of specialization. In order to be included as part of the master's program, these courses must be approved in advance by the department in which the student is specializing.

Studies Committee A Studies Committee will be appointed by the Department Chairman for each candidate for the master's degree. It shall be the responsibility of this committee to supervise the student's program and review his progress at regular intervals.

Thesis Each candidate will undertake a problem of original research under the direction of a member of the department in which he is specializing. At the conclusion of the investigation the student must present a thesis which embodies the results of his work and which demonstrates his capability for independent research.

In order to be eligible for an advanced degree in a particular academic year, a master's candidate must submit the required copies of his thesis no later than three weeks before Commencement. However each department may stipulate an earlier deadline.

A detailed statement concerning the preparation and submission of theses may be obtained from the Office of the Graduate College.

Copies of the thesis must be forwarded to the Dean of the Graduate College after the successful defense of thesis.

Examinations

a. A written comprehensive examination (two hour minimum) in the field of specialization.
b. An oral examination (one hour minimum) in defense of the thesis.

Success in the written examination is prerequisite to taking the oral examination. One re-examination only is permitted for any final comprehensive examination.

• *REQUIREMENTS FOR DEGREE OF DOCTOR OF PHILOSOPHY*

The degree of Doctor of Philosophy requires of candidates a minimum of seventy-five credit hours to be earned in courses and in thesis research.

Studies Committee Upon admission to the Graduate College, the prospective candidate for the Ph.D. degree will be assigned an interdepartmental Studies Committee by the Dean. This committee will meet at least once a semester with the candidate to advise him and to help plan his program of study. All courses taken in the program must be approved by this committee, the department chairman concerned, and the Dean of the Graduate College. The committee will also be responsible for administering and evaluating language examinations.

Courses At least forty hours must be earned in courses and seminars. The first year of each doctoral program consists almost entirely of required courses; in the following years appropriate courses are selected by the Studies Committee in consultation with the candidate. Details of each program can be obtained from the appropriate department chairman or from the Dean.

Language Requirements In order to satisfy the language requirements, each candidate must be able to comprehend the literature of his field in at least two foreign languages appropriate to his field in addition to English, or demonstrate fluent command (ability to read, write and converse) of one foreign language appropriate to his field in addition to English. The choice of the language is to be determined by the candidate's department, and the testing of the candidate is to be the joint responsibility of the candidate's department and the language departments involved. The examinations will be given only during the period September 15-October 15 and the month of March.

The language requirements must be completed before the comprehensive examination is taken.

Research and Thesis Each candidate, while in residence at The University of Vermont, must complete an acceptable original research project which contributes new knowledge or techniques in his academic field. A minimum of twenty credits will be allowed for thesis research.

In order to be eligible for an advanced degree in a particular academic year, a doctoral candidate must submit the required copies of his thesis no later than six weeks before Commencement. However, each department may stipulate an earlier deadline.

A detailed statement concerning the preparation and submission of theses may be obtained from the Office of the Graduate College.

Thesis Examining Committee Upon submission of the completed thesis, the Dean of the Graduate College will appoint a Thesis Committee for the oral examination of the candidate. The Committee shall consist of the Dean, the members of the Studies Committee, and at least two other faculty members nominated by the chairman of the department concerned. The acceptability of the thesis will be determined by the Thesis Committee.

Examinations

(a) A comprehensive written examination in the field of study must be passed by the candidate at least six months before the thesis is submitted. This examination will be prepared by the department concerned, in consultation with the candidate's Studies Committee. One re-examination only will be permitted.

(b) An oral examination, in which the candidate will be expected to defend his thesis, will be scheduled no sooner than one month after the thesis has been submitted to the department. One re-examination only will be permitted.

Copies of the thesis must be forwarded to the Dean of the Graduate College after the successful defense of thesis.

Student Expenses

Application Fee All applications for admission must be accompanied by a $10.00 application fee. This is non-refundable.

Deposit A deposit of $35 is required of each student upon notification of his admission into the Graduate College (cf. p. 14, *Admission*). A student who is admitted in order to register in July or September, who later decides not to enter the College, will receive a refund of $15 if the Dean is so notified prior to May 1; if admission is for January, the deadline is December 1. Any residue from this deposit will be returned to the student upon graduation or upon withdrawal from the College.

Tuition Rates for the academic year 1966-67 will be as follows: For Vermont residents, $22 per credit hour, with a semester maximum of $250.

For nonresidents of Vermont, $62.50 per credit hour, with a semester maximum of $750.

The lower rates for Vermont residents are made possible by a subvention to the University from the State of Vermont.

Completion of Thesis Fee A fee of $25 per semester is charged each graduate student who has already paid tuition for all credits required in his degree program but who is in residence for the purpose of completing his thesis.

Library Fee A fee of $15 per semester is required of each student enrolled in twelve credit hours or more; a fee of $7.50 per semester is required of each student enrolled for less than twelve credit hours, but more than three credit hours.

Athletic Fee A fee of $15 per semester is required of each student enrolled in twelve credit hours or more. Payment of the Athletic Fee gives each student the privilege of using the facilities in the University gymnasium and provides admission to intercollegiate home games.

Penalty Payment Failure to complete financial arrangements and registration by specified dates will result in a penalty of $10.00.

Change of Enrollment Fee A fee of $3 is charged for any change in enrollment requested by the student after registration has been completed.

Advanced Degree Fee A fee of $25, payable during the semester prior to graduation, is charged each degree candidate. This fee includes the cost of thesis binding and the academic hood.

Living Expenses At present there is no University housing for graduate students. The Housing Office, in the Military Science Building, maintains listings of available off-campus rental facilities. Students visiting the Housing Office may refer to these listings; no information from them is given telephonically or by mail. Rents vary widely in the Burlington area; $8.00 a week for single furnished room and $65.00 monthly for a furnished apartment may be regarded as minimums. Meals may be obtained in the University dining halls if desired. A student should expect overall living expenses of $125.00 to $175.00 per month.

Time Payments The University offers a time payment plan whereby total charges for tuition and fees may be divided into six equal monthly payments beginning with July 1 for the first semester and January 1 for the second semester. Arrangements should be made with the Treasurer's Office.

Refunds In the event of withdrawal from the College after registration, refunds are made as follows: during the first week of any semester, the full tuition is refunded. Thereafter, 20 percent of tuition is deducted for each week that has elapsed.

Financial Aid

Students who wish to be considered for fellowships as well as admission must submit applications, with supporting material, by March 15 for the academic year preceding that for which application is made. Application for fellowships should be made by completion of the appropriate section on the application form, except as otherwise indicated.

- *GRADUATE FELLOWSHIPS*

The Graduate College offered five Graduate Fellowships in 1965-66, each of $1,000 plus a full tuition scholarship. These fellowships are open to applicants in any field in which the University offers a graduate degree program. Holders of Graduate Fellowships are expected to carry a full-time graduate program towards an advanced degree.

- *GRADUATE TEACHING FELLOWSHIPS AND GRADUATE RESEARCH FELLOWSHIPS*

Approximately eight-five Graduate Teaching and Research Fellowships are awarded in departments offering graduate work. Graduate Teaching Fellows are usually appointed for nine months with an initial stipend of $2,200; Graduate Research Fellows for eleven months with an initial stipend of $2,640. Teaching and Research Fellows may enroll for a maximum of twelve hours per semester; they are eligible for reappointment. Fellowship award includes tuition scholarship.

A maximum of half-time assistance in the department is expected of Graduate Teaching Fellows and Graduate Research Fellows, and they must expect that more than one academic year will be necessary to complete the requirements for the master's degree. If a Teaching Fellow or Research Fellow is a candidate for the doctoral degree, he must expect to spend at least four calendar years before his academic program can be completed. While it is customary, it is not obligatory that Fellows select their fields of concentration in the departments in which they are appointed; for example, foreign-born students appointed Graduate Teaching Fellows in the Department of Romance Languages may be accepted as degree candidates by the Department of English.

Appointments will be announced on or before April 1.

- *RESIDENCE HALL COUNSELORSHIPS*

Graduate students, men and women, are eligible for appointment as residence hall counselors. Residence hall counselorships afford graduate

students opportunity to obtain practical experience in hall activities, human relationships, government and administration while pursuing an advanced degree in their chosen field of study. Residence hall counselorships are open to either married or single students who qualify for graduate work at The University of Vermont. Leadership experiences are desirable. Selection is based on character, academic record, recommendations and a personal interview. Residence hall counselors receive for the first year a stipend of $2,200 plus a tuition scholarship for a nine-month period. Room and board will be deducted from this stipend. Requests for applications and additional information should be addressed to the Dean of Men or the Dean of Women, respectively. Applications should be filed not later than March 15 of the academic year preceding that for which application is made.

• *GEORGE H. WALKER DAIRY FELLOWSHIP*

The George H. Walker Dairy Fellowship, which is awarded periodically, provides a stipend plus a full tuition scholarship. It is available to graduate students who, during their undergraduate courses, have studied "agriculture, chemistry, and bacteriology" and who desire to study the problems relating to the production of a sanitary milk supply on comparatively small plants and farms. Applications should be addressed to the Chairman of the Department of Animal and Dairy Science.

• *NATIONAL DEFENSE EDUCATION ACT FELLOWSHIPS*

The U. S. Department of Education supported fellows in several departments during the academic year 1965-66 under provisions of Title IV of the National Defense Education Act. Additional fellowships will be available in the Departments of Botany, Chemistry, Electrical Engineering, Psychology and Zoology during the academic year 1966-67.

These awards are made to predoctoral students who are U. S. citizens or nationals. They carry stipends plus a dependency allowance and include payment of tuition and nonrefundable fees. Requests for NDEA Fellowships should be indicated on the application for admission.

• *NATIONAL AERONAUTICS AND SPACE ADMINISTRATION TRAINEESHIPS*

The National Aeronautics and Space Administration has supported twelve graduate traineeships in the Departments of Chemistry, Physics and Zoology during the academic year 1965-66. Additional NASA traineeships will be available in these departments and in Botany, Elec-

trical Engineering, and Psychology during the academic year 1966-67. These awards, which are available to U. S. citizens and nationals, carry stipends plus a dependency allowance and cover payment of tuition and nonrefundable fees. Requests for traineeships should be indicated on the application for admission.

• *NATIONAL SCIENCE FOUNDATION TRAINEESHIPS*

The University of Vermont participates in the Graduate Traineeship Program of the National Science Foundation. These traineeships are open to graduate students in the natural sciences, engineering and the quantitative social sciences who are U. S. citizens or nationals. They carry a stipend plus a dependency allowance and include payment of tuition and nonrefundable fees. Requests for NSF Traineeships should be indicated on the application for admission.

• *GRADUATE TRAINEESHIPS*

Graduate traineeships have been made available to certain departments through grants from various divisions of the U. S. Public Health Service. Traineeships were awarded to graduate students enrolled in the following departments during the academic year 1965-66. Biochemistry, Pharmacology, Physiology and Biophysics, and Speech. These traineeships generally carry stipends of $2,400 upwards plus payment of tuition. The chairman of the department concerned should be contacted for information on the availability of these awards.

• *OTHER SOURCES*

Students undertaking graduate work at The University of Vermont may apply for other awards such as the National Science Foundation Graduate Fellowships and National Institutes of Health Predoctoral Fellowships. Further information concerning these programs may be obtained from the respective granting agencies.

• *LOANS*

Graduate students may apply for National Defense Student Loans. Applications should be made through the Director of Financial Aid, Waterman Building, prior to April 1 for September enrollment.

Graduate students, after they have successfully completed one semester, are also eligible for university loans on the same basis as undergraduates. Details may be obtained from the Financial Aid Office.

General Information

• *THE UNIVERSITY LIBRARIES*

The combined holdings of the University's Guy W. Bailey and Medical College Library amount to about 350,000 volumes, including subscriptions to nearly 4,000 journals.

Bailey Library, in addition to its general collection, is a depository for United States Documents, a subscriber to U. N. Documents, and to many UNESCO publications. It also subscribes, currently, to about 3,000 journals and a variety of domestic and foreign newpapers. In its Reference Collection are the major encyclopedias, indexing media, major language dictionaries, and a good and expanding variety of special and general bibliographies, biographical compilations, handbooks, guides, etc. In its Special Collections, the Wilbur Collection is strong in manuscripts, early imprints, and books dealing with Vermont Culture and History. The letters and papers of, for example, Dorothy Canfield Fisher, John Spargo, and Ambassador Warren Austin are among Wilbur materials. The private library of George P. Marsh, about 12,000 volumes, enriches Bailey Library for students in the Humanities as does the Howard-Hawkins Civil War materials, and the Whittingham-Stevens collection of Chiswick imprints.

The University's Medical College Library has a good working collection of about 20,000 volumes, and subscribes to about 900 medical journals. It is a convenient on-campus supplement to Bailey Library's scientific materials, and by 1967 will occupy new, enlarged facilities.

• *PLACEMENT SERVICE*

To assist graduates in exploring and selecting among various employment possibilities, the University and the College operates an extensive Placement Program. Under the aegis of the University Placement Service, a large number of representatives of business organizations, governmental agencies, and school systems come to the campus each year to interview for full time positions. Related services include individual career counseling and the preparation of confidential credentials.

• *GEORGE BISHOP LANE ARTISTS SERIES*

The University offers one of the largest collegiate artists series in the country. It has brought to the campus and community a continuing

program of outstanding musical, theatrical, dance and other artistic productions for a moderate admission fee. The Series has presented many of the world's finest artists and groups, including the Vienna Philharmonic, Royal Ballet of London, Rudolf Serkin, Artur Rubinstein, Van Cliburn, Victor Borge, Joan Baez, the Royal Marines Tattoo, the Philadelphia Orchestra, Dave Brubeck, the Vienna Choir Boys, the Weavers, Benny Goodman, the Budapest String Quartet, Sir John Gielgud, the New York City Opera Company, Harry Belafonte, and a number of plays. In addition to two major series presented during the academic year, the Lane Series also sponsors a Chamber Arts Series in the spring semester and the Lane Summer Series.

• *ROBERT HULL FLEMING MUSEUM*

The Museum, an integral part of the University's teaching program, provides a fourfold educational service to the University and the people of Vermont. The permanent collection is arranged to augment the University's teaching in varied fields. Particular galleries are devoted to ancient, medieval, and renaissance art; baroque and modern painting and sculpture; American art; primitive art; and the Orient. Two galleries are often devoted to temporary exhibitions which supplement the permanent collections.

Courses of Instruction

Course Numbering

Courses numbered 400 or above are limited to candidates for the degree of Doctor of Philosophy; courses numbered 300 to 399 are limited to graduate students; courses numbered 200 to 299 are graduate courses open to advanced undergraduates. For graduate credit, see p. 17.

A separate number is used for each semester course. Odd numbered courses are usually offered the first semester, even numbered courses in the second.

The form 201, 202 indicates that each semester may be taken independently for credit.

The form 201-202 indicates that they may not be taken independently for credit and, unless otherwise stated, must be taken in the sequence indicated.

The number of credit hours *per semester* is indicated in each description.

All prerequisites cited refer to courses as numbered at The University of Vermont.

A student who lacks the stated prerequisites for a course, but is otherwise qualified to take it, may be permitted to enroll by the instructor.

While every attempt has been made to list only courses that actually will be offered, the College necessarily must reserve the right to withdraw scheduled offerings or substitute for them should circumstances make such changes necessary.

• AGRICULTURAL BIOCHEMISTRY

D. B. Johnstone, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in Chemistry or Biology which shall include courses in Organic Chemistry, Quantitative Analysis and Biochemistry. A course in Physical Chemistry is strongly recommended.

MINIMUM DEGREE REQUIREMENTS

Agricultural Biochemistry 201, 250, 381-384; Chemistry 237; thesis research (12-15 hours).

For the Master's program in Microbiology, see under Microbiology. Cf. also Medical Microbiology.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Chemistry 131-132 and 141-142, Mathematics 21, Physics 14-15 or their equivalents; a year course in a biological science. See similar program under Biochemistry (Medical).

MINIMUM DEGREE REQUIREMENTS

Biochemistry 301, 302, 303-304; satisfactory participation in biochemistry seminars during residency; advanced courses in Chemistry (10 hours); (10 hours) of courses other than Biochemistry and Chemistry; balance of course work from Agricultural Biochemistry and Medical Biochemistry; a reading knowledge of German and one other appropriate foreign language; and doctoral thesis research (30 hours).

COURSES OFFERED

201 GENERAL BIOCHEMISTRY Broad coverage of fundamentals of biochemistry for science students, including the chemistry of carbohydrates, proteins, lipids, vitamins, enzymes, and hormones and their relation to processes of biological significance. Basic principles of analytical procedures involved in biochemical methods. *Prerequisite:* Chemistry 131. Five hours. Mr. Foote.

250 ADVANCED BIOCHEMISTRY An advanced study of biochemical systems with emphasis on research methods and plant biochemistry. Laboratory sessions include the use of radioisotopes and chromatographic techniques. This course augments Agricultural Biochemistry 201 (General Biochemistry), the combined sequence providing a base for graduate research in biochemistry and related fields. *Prerequisite:* 201 or Medical Biochemistry. Five hours. Mr. Racusen.

253 MICROBIAL BIOCHEMISTRY An advanced course dealing with the chemical composition, energy utilization and metabolism of microbial cells. *Prerequisite:* 201 or Biochemistry 301, Botany 116, permission of the department. Three hours. Offered alternate years, 1965-66. Mr. Johnstone.

381, 382, 383, 384 SEMINAR A topical seminar with discussion of assigned and collateral reading. Required of graduate students in agricultural biochemistry. One hour.

391 THROUGH 399 MASTER'S THESIS RESEARCH See under Biochemistry.

491 THROUGH 499 DOCTOR'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

A major research project in the Department of Agricultural Biochemistry is the study of biochemical events in leaf growth. The current effort is a study of leaf-protein synthesis and degradation using carbon-14 labelling. Work is also in progress to develop methods of protein isolation, measurement, and characterization. It is expected that research will be extended to the synthesis of leaf-nucleic acids. Biochemistry research on microorganisms is concerned

with carbohydrate and pigment synthesis, pesticide degradation, fluorescence, and nitrogen fixation.

• AGRICULTURAL ECONOMICS

F. O. Sargent, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

A major in some phase of Agriculture or in Economics; undergraduate courses in Agricultural Economics, Economics, and Mathematics.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in Agricultural Economics, Economics, and related fields (15-24 hours); thesis research (6-15 hours).

COURSES OFFERED

201 FARM MANAGEMENT Organization and operation of a successful farm business. *Prerequisite:* Economics 11-12 or concurrent enrollment; junior standing. Four hours. Mr. Tremblay.

207 AGRICULTURAL MARKETING AND PRICES Market structure, prices, and economic forces involved in the movement of farm products from producers to consumers. Emphasis on the New England situation. *Prerequisite:* Economics 11-12 or permission of the instructor. Three hours. Mr. Webster.

208 AGRICULTURAL POLICY The role of government, farm organizations, and other institutions in the development of agricultural policy. An economic analysis of the price and income problems of American agriculture and alternative solutions. *Prerequisite:* Economics 11-12 or permission of the instructor. Three hours. Mr. Sinclair.

253 THEORY OF AGRICULTURAL PRODUCTION ECONOMICS Application of the theory of the firm to agricultural production units. Emphasis on resource allocation and production efficiency. Principles of marginal analysis applied to production problems in a static and dynamic economy. *Prerequisite:* twelve hours in agricultural economics and/or economics, senior standing, and permission of the department. Three hours (either semester). Mr. Sinclair.

255, 256 SPECIAL TOPICS IN AGRICULTURAL ECONOMICS Readings and discussion of specific topics in agricultural economics at advanced level. *Prerequisite:* permission of the department. One to three hours. Staff.

270 AGRICULTURAL DEVELOPMENT Problems of economic development of underdeveloped agricultural countries. Levels of economic development, prerequisites to development, land reform, theories of development, investment priorities, terms of trade, and national development programs. *Prerequisite:* twelve hours in economics and/or agricultural economics. Two hours. Mr. Sargent.

381-382 AGRICULTURAL ECONOMICS SEMINAR Discussion of problems, research and theory in agricultural economics and other social sciences. One hour. Staff.

351 RESEARCH METHODS The scientific method, statistical methods, sampling methods, use of electronic computers, linear programming, reporting research results. *Prerequisite:* three hours of statistics. Three hours. Mr. Webster.

391 THROUGH 394 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

The Department of Agricultural Economics is a department of the Vermont Agricultural Experiment Station and the Vermont Resources Research Center. Department members conduct research in agricultural production economics, farm management, marketing, regional development, recreation, electronic business records analysis, rural sociology, agricultural finance, and agricultural and resource policy.

Undergraduate courses:

2 World Food and Agriculture
51 Agricultural Finance
66 Agricultural Business
103 Rural Sociology
203 Land Economics

• AGRICULTURAL EDUCATION

B. A. Gaylord, Chairman

The degree of Master of Arts in Teaching (see p. 20) is offered for those candidates who specialize in the field of Agriculture. Candidates for this degree work under the supervision of the Department of Agricultural Education.

COURSES OFFERED

251 TEACHING VOCATIONAL AGRICULTURE II Study of various advanced topics in the field. *Prerequisites:* 104 and 152, or permission of the department. Three hours. Mr. Gaylord.

253 METHODS OF TEACHING YOUNG AND ADULT FARMER GROUPS Needs, problems, and objectives for the education of farmers. *Prerequisites:* 104 and 152, or permission of the department. Three hours. Mr. Gaylord.

282 SEMINAR Evaluation of student teaching experiences. *Prerequisites:* 104, 155, 251 or 253. Mr. Gaylord.

301, 302, 303, 304 RESEARCH IN AGRICULTURAL EDUCATION Investigation of a research topic under the direction of an assigned staff member. Credit as arranged.

Research in the Department of Agricultural Education is designed to solve practical problems identified in the areas of adult education, psychology of learning, improvement of instruction, and other areas in the field of education in agriculture.

Undergraduate courses:

104 Leadership Training and Organization Methods
102 Extension Methods
152 Teaching Vocational Agriculture I
155 Directed Practice Teaching
197, 198 Senior Research

• ANATOMY

C. A. Newhall, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Academic requirements as agreed upon for each candidate.

MINIMUM DEGREE REQUIREMENTS

In Gross Anatomy: 301, 302; 311; 322; 331-332; 341, 342; 381, 382; 391, 392; Physiology and Biophysics 301-302.
In Histology: 311; 322; 351, 352; 383, 384; 393, 394; Biochemistry 301-302.
In Neuroanatomy: 311; 322; 371, 372; 387, 388; 397, 398; Biochemistry 301-302.

COURSES OFFERED

301-302 GROSS ANATOMY The course as given to medical students. Study of the gross structure of the human body by means of general dissection, cross-sections and special dissections. Fourteen hours (7 hours per semester). Dr. Newhall and Mr. Stultz.

311 MEDICAL HISTOLOGY The regular medical course. Microscopic study of cells, tissues and organs using routine techniques. Six hours. Messrs. Dunihue and Freedman.

322 NEUROANATOMY As designed for the regular medical curriculum. Gross and microscopic study of the central nervous system, by means of dissection of the brain, accompanied by microscopic examination of stained sections and reconstructions of the principal nervous pathways. Four hours. Messrs. W. Chambers and Freedman.

331, 332 SURFACE AND RADIOLOGICAL ANATOMY A course in Living Anatomy in which all available landmarks are studied and utilized in the placement of internal structures. A complete series of radiological plates is used to correlate radiological landmarks with the positions of deep structures. *Prerequisite:* 301-302. Two hours. (1 hour per semester.) Mr. Stultz.

341, 342 SPECIAL PROBLEMS IN GROSS ANATOMY Special dissections of particular regions of the human body, utilizing either adult or fetal material,

or investigative work designed to advance knowledge of some special structure or relationship. *Prerequisite:* 301-302. Credit as arranged. Mr. Stultz.

351, 352 PROBLEMS IN SPECIAL HISTOLOGY A study of selected cells, tissues or organs by means of special techniques. *Prerequisite:* 311. Credit as arranged. Mr. Dunihue.

361, 362 SPECIAL PROBLEMS IN EMBRYOLOGY The study of some particular embryological problem utilizing special techniques, with directed reading. *Prerequisite:* Undergraduate course in Comparative Embryology (such as Zoology 111) and, in particular cases, in Experimental Embryology (as Zoology 222). Credit as arranged. Mr. Stultz.

371, 372 PROBLEMS IN SPECIAL NEUROANATOMY The study of some particular phase of Neuroanatomy, as selected by mutual consent, including minor investigations designed to serve as an introduction to research. *Prerequisite:* 322 or its equivalent. Credit as arranged. Mr. W. Chambers.

SEMINARS IN ANATOMY Attendance at departmental or sectional seminars. Review of the recent literature and findings in one or another of the various branches of Anatomy. *Prerequisite:* graduate standing. Credit as arranged. Seminars as follows:

381, 382 Gross Anatomy	385, 386 Embryology
383, 384 Medical Histology	387, 388 Neuroanatomy

MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, designed to culminate in an acceptable Master's thesis. Credit as arranged. Master's Thesis Research as follows:

391, 392 Gross Anatomy	395, 396 Embryology
393, 394 Medical Histology	397, 398 Neuroanatomy

Research activities in the Department of Anatomy include a study of the developmental mechanics of the vertebrate form, utilizing embryos of the salamander, Amblystoma punctatum, and carried out by means of transplantation experiments on the limbs and nervous system; an electron microscope study of the structure of the renal glomerulus and juxtaglomerular apparatus under various experimental conditions; an electron microscope study of the Purkinje-myocardial fiber junction; and an electrophysiological study of the effects of endocrine alterations on nervous system function; neural control of reproduction.

• ANIMAL AND DAIRY SCIENCE

A. M. Smith, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An acceptable undergraduate major in Animal and Dairy Science, in a related Agricultural field, or in Chemistry.

MINIMUM DEGREE REQUIREMENTS

281, 282 (3 hours); additional courses in Animal and Dairy Science and related fields, thesis research (10-15 hours).

COURSES OFFERED

206 ANIMAL NUTRITION Nutrients, their function and utilization, and requirements for growth, reproduction and lactation. *Prerequisite:* 105. Three hours. Mr. Smith.

211 ICE CREAM AND FROZEN DAIRY PRODUCTS Fundamentals of ice cream manufacturing, the physio-chemical and biological factors involved; calculation of formulas; sherbets and specialties; merchandising, soda fountain management and sanitary control. *Prerequisite:* 104; credit or concurrent enrollment in 109. Three hours. Mr. Bradfield. Alternate years, 1965-66.

251 DAIRY CATTLE AND MILK PRODUCTION Advanced principles of dairy cattle feeding and management. *Prerequisite:* 105. Three hours. Mr. Fitzsimmons.

256 DAIRY PLANT MANAGEMENT The organization and operation of milk processing and manufactured milk products plants. *Prerequisites:* 153; Economics 11-12. Two hours. Mr. Bradfield. Alternate years, 1966-67.

260 DAIRY CATTLE BREEDING Theory and application of genetic principles to breeding of dairy cattle. *Prerequisite:* 1, Zoology 115 or permission of the department. Three hours. Mr. Fitzsimmons.

271 ENDOCRINOLOGY Anatomy, physiology, glandular interrelationships, and assay methods of the endocrine glands and their hormones. *Prerequisite:* Zoology 1 and the permission of the department. Three hours. Mr. Simmons.

276 PHYSIOLOGY OF REPRODUCTION AND LACTATION Fundamental principles of the physiology of reproduction and lactation with the primary emphasis on farm animals. *Prerequisite:* 271 or permission of the department. Three hours. Mr. Simmons. Alternate years, 1966-67.

281, 282 ANIMAL AND DAIRY SCIENCE SEMINAR Reports and discussions of problems and special investigations in selected fields. Credit as arranged. Staff.

291, 292 SPECIAL PROBLEMS IN ANIMAL AND DAIRY SCIENCE Reading, discussion, and special laboratory investigations in the field of Animal and Dairy Science. Three hours. Staff.

294 HISTORY OF NUTRITION This course is identical with Home Economics 294, see p. 79.

307 ADVANCED CONCEPTS IN NUTRITION This course is identical with Poultry Science 307, see p. 107.

308 EXPERIMENTAL TECHNIQUES IN NUTRITION Methods of conducting research in nutrition with various animal species including humans. Physical, physiological and biochemical aspects considered. Experimental design and analyses. *Prerequisites:* A 200 level course in nutrition and in biochemistry. Two hours. Miss Morse and Messrs. Smith and Donovan.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Research in the Department of Animal and Dairy Science is directed toward the solution of basic and practical problems. The areas of study and research include livestock management; breeding; nutrition; physiology; dairy plant management; and the bacteriology and chemistry of milk and milk products.

Undergraduate courses:

1 Introductory Dairy Science
2 Milk and Milk Products
4 Introductory Animal Science
44 Dairy Cattle Judging
95 Light Horse Production and Management
97 Beef Cattle and Sheep Production
104 Dairy Testing and Quality Control
105 Feeds and Feeding
109 Dairy Bacteriology Products
114 Manufactured Dairy Products
121 Sensory Evaluation of Foods
153 Milk Processing
197 Senior Research
198 Senior Research

• ANIMAL PATHOLOGY

W. D. Bolton, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

The degree of Doctor of Veterinary Medicine.

MINIMUM DEGREE REQUIREMENTS

Pathology 301 or Medical Microbiology 201; additional courses in related fields; thesis research (12-15 hours).

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Research interests in the Department of Animal Pathology include causes of abortions and breeding problems in dairy cattle. Virus agents, plant estrogens and nitrate levels in native roughage are of special interest.

Undergraduate courses:

105 Anatomy and Physiology
106 Animal Diseases
116 Poultry Diseases

• BIOCHEMISTRY

D. B. Melville, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Year courses in organic chemistry, physical chemistry, and physics (equivalent to Chemistry 131-132, Chemistry 141-142, and Physics 14-15); quantitative chemistry; mathematics through differential and integral calculus; a year course in a biological science.

MINIMUM DEGREE REQUIREMENTS

Biochemistry 301, 302, 303-304; additional courses in Biochemistry; thesis research; a reading knowledge of German or French.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Year courses in organic chemistry, physical chemistry, and physics (equivalent to Chemistry 131-132, Chemistry 141-142, and Physics 14-15); quantitative chemistry; mathematics through differential and integral calculus; a year course in a biological science. See similar program under Agricultural Biochemistry. Cf. also p. 32.

MINIMUM DEGREE REQUIREMENTS

Twenty hours from graduate courses offered by the Departments of Biochemistry and Agricultural Biochemistry, including Biochemistry 301, 302, 303-304, and participation throughout residence in Biochemistry Seminar; ten hours from graduate courses offered by the Department of Chemistry; ten additional hours from courses in physical or biological sciences; thirty hours of Doctoral Thesis Research; a reading knowledge of German and one other appropriate foreign language.

COURSES OFFERED

301 BIOCHEMISTRY I Lectures, conferences, and assigned reading in the area of molecular biochemistry: chemistry, structure, and metabolism of proteins, amino acids, nucleic acids, lipids, and carbohydrates; enzymes. *Prerequisite:* Chemistry 131-132 and permission of the department. Three hours. Staff.

302 BIOCHEMISTRY II Lectures, conferences, and assigned reading in the area of biochemistry of the whole organism, with special reference to man: respiration, hemoglobin, plasma proteins, and iron metabolism; acid-base balance, water balance, and mineral metabolism; vitamins; hormones. *Prerequisite:* 301 and permission of the department. Three hours. Staff.

303-304 BIOCHEMISTRY LABORATORY Experimental work designed to demonstrate important principles and to illustrate methods and techniques of modern biochemistry. *Prerequisite:* 301 and 302, or concurrent registration therein, and permission of the department. Two hours per semester. Messrs. Meyer and Woodworth.

311, 312 BIOCHEMICAL PREPARATIONS Laboratory procedures and techniques for the synthesis, isolation, and characterization of compounds of biochemical interest. *Prerequisite:* 301. Two hours per semester. Mr. Melville.

320 GENERAL ENZYMOLOGY A general consideration of enzyme nomenclature, purification, assay, introductory kinetics, mechanisms, cofactors, active sites, and the relationship of enzyme structure to the biological control of activity. *Prerequisites:* 301; Chemistry 141-142. Two hours. Mr. Meyer.

321 ENZYME KINETICS AND MECHANISMS Topics include kinetics, specificity, inhibitors, enzyme-substrate interactions, and their relation to enzyme structure. *Prerequisites:* 301; Chemistry 141-142. Two hours. Mr. Gjessing.

331 NUCLEIC ACIDS The structure and function of ribonucleic acids and deoxyribonucleic acids. *Prerequisite:* 301. Two hours. Mr. Schein.

351 INTERMEDIARY METABOLISM Current concepts of the internal transformations of amino acids, carbohydrates and lipids. Dynamic state of the body constituents, application of isotopes, and other topics. *Prerequisite:* 301. Three hours. Staff.

371 PHYSICAL BIOCHEMISTRY Protein interaction, solubility and fractionation, electrophoresis, sedimentation, phase rule study, diffusion, viscosity, spectrophotometry, and related topics. *Prerequisites:* 301; Chemistry 141-142. Two hours. Mr. Woodworth.

381 THROUGH 389 SEMINAR A review of recent developments and current literature in the various fields of biochemistry. *Prerequisite:* permission of the department. One hour per semester.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable Doctoral dissertation. Credit as arranged.

Current research in the Department of Biochemistry includes projects concerned with amino acid metabolism in animals and microorganisms; the metabo-

lism of purines, pyrimidines, and related compounds; the structure of nucleic acids; the effects of ascorbic acid on bone metabolism; pancreatic proenzyme relationships; the structure of metalloproteins; and factors involved in the control of enzyme activities.

• BIOMEDICAL ENGINEERING

A cooperative program offered by the Department of Electrical Engineering (*W. Roth, Chairman*) and the Division of Biophysics (*F. J. M. Sichel, Chairman*). (Cf. p. 59.)

PREREQUISITES EOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited Bachelor's degree in Electrical Engineering; a year course in Biology; a year course in Physical Chemistry.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301-302; twelve hours in Electrical Engineering, Physics and Mathematics; additional approved courses; thesis research (6-12 hours) in the Department of Electrical Engineering.

• BOTANY

B. B. Hyde, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Six semester courses in Botany; supporting courses in other sciences and in Mathematics.

MINIMUM DEGREE REQUIREMENTS

15-21 hours in Botany and closely related fields; thesis research (9-15 hours).

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The following courses must have been satisfactorily completed: four semesters in Botany; two semesters in Zoology; a year in Organic Chemistry (Chemistry 131-132 at the University of Vermont or its equivalent); a year of Mathematics comparable to Mathematics 11-12 and in some cases Mathematics 21 or its equivalent; one year in Physics, *i.e.*, Physics 5-6 or its equivalent. In addition, a candidate must have completed one academic year, but not more than two years, in graduate study at the University of Vermont. (With the approval of the Dean of the Graduate College and the Department of Botany, a Master's degree may be accepted as partial or complete fulfillment of this requirement.) In addition, the candidate must have completed satisfactorily the general qualifying examination administered by the Department of Botany.

MINIMUM DEGREE REQUIREMENTS

The candidate is required to accumulate a minimum of 75 credits from course work and thesis research. The course requirements are as follows: a total of at least 40 credit hours of which at least 20 must be taken in Botany and at least 20 in other sciences. Supervised teaching to the extent of not less than 6 semester contact hours is also requisite. The specific language requirement for the candidate is to demonstrate ability to comprehend the contents of articles in the biological sciences in German and also in either French or Russian. This language requirement must be completed within the first two years after acceptance to the program.

COURSES OFFERED

205 MINERAL NUTRITION OF PLANTS This course is identical with Plant and Soil Science 205, see p. 102.

252 PLANT ANATOMY AND HISTOLOGY Development of the organism and accompanying integration of cellular tissues. Ontogeny of vegetative tissues; modification of the cell wall. *Prerequisite:* 2 or departmental permission. Four hours. Mr. Taylor. Alternate years, 1966-67.

253 FUNGI The reproductive processes of the common molds, yeasts, and actinomycetes and their classification. Physiological studies; antibiosis. *Prerequisite:* 103 or departmental permission. Four hours. Mr. Sproston. Alternate years, 1965-66.

255 GENETICS AND CYTOGENETICS Fundamental principles of genetics. Analysis of mendelian inheritance, recombination in higher plants and animals as well as microorganisms, chromosome aberrations, polyploidy. Gene action and introduction to molecular genetics. *Prerequisites:* 1 or Zoology1; Zoology 115 and at least 8 additional hours of Botany or Zoology. Four hours. Mr. Hyde.

256 CYTOLOGY The dynamics of the protoplast; nuclear division, gamete formation, and syngamy. Ultrastructure of cell organelles; nucleocytoplasmic interaction. *Prerequisites:* 255 or Zoology 115; Chemistry 131-132 or 35 or departmental permission. Four hours. Mr. Hyde. Alternate years, 1966-67.

258 PLANT GROWTH The nutrition of plant cells, growth hormones, cyclic variation of environmental factors, morphogenesis. *Prerequisites:* 103; Chemistry 131-132 or 35 or permission of the department. Four hours. Mr. Marvin. Alternate years, 1965-66.

259 MORPHOLOGY AND EMBRYOLOGY Comparative study of body form, ontogeny of reproductive structures and phylogenetic relationships in the embryophytes; emphasis on seed plants. *Prerequisite:* 2 or departmental permission. Four hours. Miss Raynor. Alternate years, 1966-67.

260 PHYCOLOGY The morphology, classification, and general biology of the algae, with special consideration of the freshwater forms. Emphasis on the use of algae as experimental material for the investigation of general biological problems. *Prerequisites:* 2, and 2 courses in Zoology or Botany above 100. Four hours. Mr. Cook. Alternate years, 1965-66.

381-384 SEMINAR A topical seminar with discussion of assigned and collateral reading. Required of graduate students in Botany. One hour. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

The Botany Department has active research projects in legume genetics; plant tissue culture and morphogenesis; the effects of light on sexual reproduction in ascomycetous fungi; the isolation and identification of naturally-occurring fungicides; translocation and other physiological problems of woody plants; forest ecology; pollen analysis; biosystematics of vascular plants; morphogenetic studies in the algae and studies of host parasite relationships between algae and aquatic fungi; genetic and non-genetic variation in soil-inhabiting bacteria; physiology and pathogenecity of parasitic microorganisms; ultrastructural changes in the nucleus associated with development.

Undergraduate courses:

1 Introductory Botany
2 The Plant Kingdom
S10 Field Botany
51 Plants and Man
55 Introductory Microbiology
60 Plant Ecology
103 Plant Physiology
110 Taxonomy
113 Plant Communities
117 Plant Pathology
156 Advanced Microbiology
197, 198 Senior Research

• CHEMISTRY

W. N. White, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Four years of college chemistry, including Inorganic, Analytical, Organic, and Physical Chemistry; a year of physics and a year of calculus; a reading knowledge of German is strongly recommended.

MINIMUM REQUIREMENTS FOR MASTER OF SCIENCE DEGREE

Six semester hours of graduate-level courses in one field of chemistry and three semester hours of graduate level courses in another area of chemistry; additional

hours of advanced courses; thesis research; demonstration of a reading knowledge of German; demonstrated proficiency in the four fields of chemistry.

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The following courses, or their equivalent, must have been satisfactorily completed: Mathematics 21, Chemistry 21-22, 131-132, 141-142, at least three semester hours of graduate level physical chemistry, six semester hours of graduate level courses in one field of chemistry and six semester hours of graduate level courses in other areas of chemistry. In addition the candidate must have completed at least a year in residence at the University, have satisfactorily performed at least six semester hours of teaching, have demonstrated satisfactory proficiency in one of the two required foreign languages (German, French or Russian) and have demonstrated proficiency in the four fields of chemistry.

COURSES OFFERED

212 ADVANCED INORGANIC CHEMISTRY Chemistry of the elements; relation of structure to properties and to coordination compounds, complex ions, radioactivity, and stereoisomerism. *Prerequisite:* credit or concurrent enrollment in 141-142 (first semester). Three hours. Mr. Waters.

224 INSTRUMENTAL ANALYSIS Theory and practice of optical, electrometric, chromatographic, and radiochemical methods of analysis. *Prerequisite:* 11-12 or 123, 141 and credit for or concurrent enrollment in 142. Four hours. Mr. Whitcher.

231 PHYSICAL ORGANIC CHEMISTRY—PRINCIPLES Structure-reactivity relationships, quantum organic chemistry, molecular properties and their interpretation, kinetics and catalysis. *Prerequisites:* 132; 142 or 247 or permission of instructor. Three hours. Alternate years, 1966-67. Mr. White.

233 PHYSICAL ORGANIC CHEMISTRY—MECHANISMS Methods and results of investigations of mechanisms of common organic reactions. *Prerequisites:* 132; 142 or 247 or permission of instructor. Three hours. Alternate years, 1965-66. Mr. Krapcho.

237 IDENTIFICATION OF ORGANIC COMPOUNDS AND ADVANCED TECHNIQUES IN ORGANIC CHEMISTRY Methods, both chemical and physical, of identifying organic compounds, their separation, and the determination of their functional groups. Experiments with infrared and ultraviolet spectroscopy, vapor phase chromatography, thin layer—paper—and column chromatography, selective oxidations and reductions, synthetic reactions, isolation and purification of a natural product. *Prerequisite:* 131-132; credit or concurrent enrollment in 141-142 Five hours. Mr. Kuehne.

247 INTRODUCTION TO QUANTUM MECHANICS General considerations of quantum mechanics. Development of techniques pertinent to the

application of quantum mechanics to chemical problems. *Prerequisite:* 141-142 or equivalent. Three hours. Mr. Brooks.

248 CHEMICAL THERMODYNAMICS Systematic study of the application of thermodynamics to chemical problems. Concepts of statistical thermodynamics to be introduced. *Prerequisite:* 141-142 or equivalent. Three hours. Mr. Wulff.

249 CHEMICAL STATISTICAL MECHANICS Development of statistical mechanics and its application to problems of chemical interest. *Prerequisite:* 141-142 or equivalent; 247 recommended. Three hours. Mr. Flanagan.

251, 252 ADVANCED ORGANIC CHEMISTRY A detailed discussion of systematic organic chemistry with emphasis on important synthetic methods and stereochemistry. Kinetic and stereochemical approaches to reaction mechanisms will be introduced. *Prerequisites:* Chemistry 131-132, credit or concurrent enrollment in Chemistry 141-142, Chemistry 251 for 252. Three hours. Messrs. Kuehne and Krapcho.

332 NATURAL PRODUCTS—THE ALKALOIDS The major classes of alkaloids will be surveyed from a biogenetic point of view. Classical and modern degradation methods, total syntheses and biosynthetic incorporation of labeled compounds will be discussed. *Prerequisite:* 251, 252 or concurrent enrollment in 252 or the equivalent with permission of the instructor. Three hours. Alternate years, 1965-66. Mr. Kuehne.

334 NATURAL PRODUCTS—THE TERPENES The chemistry of monosesquidi- and triterpenes, including degradations, structure proofs, total syntheses, rearrangement reactions and biogenesis. *Prerequisite:* 251, 252 or concurrent enrollment in 252 or the equivalent with permission of the instructor. Three hours. Alternate years, 1966-67. Mr. Kuehne.

336, 338 SPECIAL TOPICS IN ORGANIC CHEMISTRY Advanced level discussion of specific topics in organic chemistry of current interest such as photochemistry, carbenes, bio-organic chemistry, magnetic resonance, etc. *Prerequisite:* permission of instructor. Credit as arranged. 336 and 338 offered in alternate years. Staff.

342 CHEMICAL KINETICS Fundamentals of chemical kinetics: collision theory, absolute rate theory, applications to organic and physical chemistry. *Prerequisite:* 247 and 248 or 249 or permission of the instructor. Three hours. Alternate years, 1966-67. Messrs. Flanagan and Krapcho.

344 QUANTUM CHEMISTRY—Applications of quantum mechanical techniques to problems of chemical interest. *Prerequisite:* 274. Three hours. Alternate years, 1966-67. Mr. Brooks.

345, 346, 347 SPECIAL TOPICS IN PHYSICAL CHEMISTRY Advanced level discussion of specific topics in physical chemistry and chemical physics;

group theory, solid state theory, irreversible thermodynamics, solution theory. Credit as arranged. Offered as occasion warrants. Staff.

371, 372 METHODS OF CHEMICAL INVESTIGATION Introduction to advanced modern chemical methods. Primarily for chemistry doctoral students. *Prerequisite:* permission of department chairman. Two hours. Staff.

380 RESEARCH PROBLEM CONCEPTION AND SOLUTION Independent origination of research problems and the methods of their solution. Required of all doctoral candidates. *Prerequisites:* two years of graduate work and permission of department chairman. One hour. Staff.

381, 382, 383, 384 SEMINAR Current problems and literature. One hour. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable Doctoral dissertation. Credit as arranged. Staff.

Current research in organic chemistry includes studies on organic sulfur compounds; the nucleophilic reactions of bivalent carbon species; the reactivity of spiro systems; the chemistry of quinone methides; studies in free radical chemistry; the synthesis of naturally occurring compounds; problems relating to biogenesis; mechanisms of aromatic rearrangements; molecular orbital correlation of reactivity; enzyme studies.

Physical chemistry research projects include heterogeneous kinetics; solid state chemistry; the thermodynamics of hydrogen-palladium systems; electrochemical studies; studies on the thermodynamics of ionic solutions; and quantum chemical calculations.

Research in inorganic chemistry includes investigations of coordination complexes and boron-nitrogen compounds.

Undergraduate courses:

1-2 Introductory Chemistry
3-4 Outlines of Chemistry
11-12 General Chemistry
13-14 The Chemical Bond
123 Elementary Quantitative Analysis
108 Inorganic Preparations
131-132 Organic Chemistry
140 Physical Chemistry for Biological Science Majors
141-142 Physical Chemistry
143 Molecular Structure
144 Physical Chemistry Laboratory
145 Advanced Physical Chemistry Laboratory

• CIVIL ENGINEERING

R. V. Milbank, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

A Bachelor's degree in Civil Engineering, or its equivalent.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in Civil Engineering, Mathematics, additional approved courses; thesis research (6 hours).

COURSES OFFERED

231 MECHANICS OF MATERIALS II The study of stresses and strains at a point under plane and three-dimensional loading using Mohr's circle; failure theories; energy methods; plastic design; buckling of plates and shells. *Prerequisites:* 176 or concurrent enrollment. Three hours. Mr. Fay.

232 ADVANCED DYNAMICS The study of Coriolis acceleration; gyroscopic forces; dynamic measurements; vibrations, earthquakes, and blast shocks on structures. *Prerequisites:* 130; Mathematics 211. Three hours. Staff.

234 ADVANCED MECHANICS OF MATERIALS The theory of elasticity with applications to curved beams, combined stresses, torsion of non-circular sections; relaxation procedures. *Prerequisites:* 131; Mathematics 212. Three hours. Mr. Stearns.

235 PHOTOELASTICITY Development of the theories of photoelastic stress analysis; model similitude; correlation with other stress analysis techniques. Laboratory work on two-dimensional applications such as stress concentrations around holes, notches, and fillets. *Prerequisites:* 131; Mathematics 211. Three hours. Mr. Fay.

250 CIVIL ENGINEERING SYSTEMS ANALYSIS Applications of systems engineering techniques to civil engineering problems. Presentation of current developments. *Prerequisite:* Senior or graduate standing, and consent of the instructor. Three hours. Staff.

261 HYDROLOGY The basic theory of precipitation, run-off infiltration and ground water; precipitation and run-off data; application of the data for use in development of water resources. *Prerequisite:* 162 or Mechanical Engineering 142. Three hours. Mr. Ragan.

262 WATER POWER ENGINEERING Hydrologic, hydraulic, and geologic studies of water power sites; selection of turbines and equipment; economic considerations. *Prerequisite:* 162 or Mechanical Engineering 142. Three hours. Staff.

263 ADVANCED HYDROLOGY Application of recent developments to problems in engineering hydrology; the concept and use of the instantaneous unit hydrograph; study of models using a numerical solution of the de Saint Venant equations; flow through porous media. *Prerequisites:* 261, Mathematics 211. Three hours. Mr. Ragan.

264 OPEN CHANNEL FLOW Application of the basic laws of fluid mechanics to flow in open channels; boundary layer theory; design of channels and transition structures; non-uniform flow; use of characteristics in the solution of unsteady; non-uniform, spatially varied flow problems. *Prerequisites:* 162, Mathematics 211. Three hours. Staff.

265 WATER TREATMENT PROCESSES A rigorous study of the theoretical concepts involved in the operation of water and waste-water treatment processes. *Prerequisite:* 166, Mathematics 211. Three hours. Mr. Ragan.

273 SOIL MECHANICS II. Index and engineering properties of soils with emphasis on current research problems. Critical evaluation of the theories of ground water movement, frost action, consolidation, shearing strength, and stress distribution. Case histories and comparison of failure conditions with predictions based on laboratory tests. *Prerequisite:* 173. Three hours. Mr. Knight.

274 SOIL ENGINEERING Applications of soil mechanics to special problems of earth structures and foundations. Topics considered include bearing capacity evaluation, earth pressures, stabilization, effects of vibratory loading, earth dam and roadway construction. *Prerequisite:* 273. Three hours. Mr. Knight.

275 INDETERMINATE STRUCTURES II Analysis of trusses with redundant members, elastic weights and column analogy methods for indeterminate frames, energy methods for curved frames and closed rings, arch theory and cable analysis. *Prerequisite:* 175. Three hours. Mr. Stearns.

276 ULTIMATE STRENGTH DESIGN Development of ultimate load theory; virtual work and statical methods of analysis. Design of structural steel and reinforced concrete structures by ultimate load methods; consideration of shear, axial force, buckling, and rotation capacity. *Prerequisites:* 155, 175. Four hours. Staff.

280 HIGHWAY AND AIRPORT PAVEMENT DESIGN Structural design of flexible and rigid pavements; types of wheel and axle configurations; tire pressures; soil classification; compaction of soils; frost action; subsurface drainage; design of bases and subbases; soil stabilization; theory of stresses in flexible pavements; plate bearing, triaxial and CBR methods of design; mix-design methods; Westergaard analysis for rigid pavements; design of joints and reinforcing steel; rigid pavement pumping; pavement evaluation; pavement selection criteria; and test roads. *Prerequisite:* 173. Four hours. Mr. Knight.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

The Department of Civil Engineering is presently conducting research in water resources; thermal stresses in flat plates; and safety factors against failure of alluvial soils.

Undergraduate courses:

24 Statics
51, 52 Surveying
113 Concrete and Bituminous Laboratory
114 Mechanics of Materials Laboratory
130 Dynamics
131 Mechanics of Materials I
140 Statically Determinate Structures
151 Engineering Contracts
155 Reinforced Concrete
158 Substructure Analysis and Design
162 Hydraulics
165 Water Supply Engineering
166 Sewerage and Sewage Treatment
168 Hydraulics Laboratory
173 Soil Mechanics I
174 Transportation Engineering
175 Indeterminate Structures I
176 Advanced Structural Design
180 Engineering Investigation

• COMMERCE

D. A. LeSourd, Chairman [Commerce and Economics]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Twenty-four hours in Economics including eighteen in courses numbered above 100 and twelve hours including six in courses numbered above 100 in a related field, OR forty-two hours in the field of commerce and business administration; a year course in History.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours in approved courses in Economics numbered above 200, including 201 and 286 (unless taken as an undergraduate); thesis research (6 hours).

For course listings, see under *Economics.*

• ECONOMICS

D. A. LeSourd, Chairman [Commerce and Economics]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Twenty-four hours in Economics, including eighteen hours in courses numbered above 100; twelve hours in a related field, including six hours in courses numbered above 100; six hours in History; a reading knowledge of a modern foreign language.

MINIMUM DEGREE REQUIREMENTS

Economics 201 or 293-294; 286 and/or 377; 295 and 296, or two of 203, 205, 206, 208, 290, 291, 297, 298, 387; additional approved courses; thesis research (6 hours).

COURSES OFFERED

201 MONEY AND BANKING Commercial and central banking with special attention given to the Federal Reserve System. Monetary theory and policy. *Prerequisite:* 12. Three hours. Mr. Alnasrawi.

203 ECONOMICS OF TAXATION Revenues and expenditures of federal, state, and local governments and their effects upon individuals, business institutions, and the national economy. *Prerequisite:* 11-12. Three hours. Mr. LeSourd.

204 STATE AND LOCAL FINANCE Revenues, expenditures and debt management problems of state and local governments; including an analysis of state and local fiscal relationships. *Prerequisite:* 11-12. Three hours. Mr. LeSourd.

205 INTERNATIONAL TRADE AND FINANCE Empirical basis of international trade; theory of international values; mechanism of adjustment of international balances; mechanics of international finance; foreign exchange theory. *Prerequisite:* 11-12. Three hours. Mr. Wass.

206 SECURITIES MARKETS Operation of organized and over-the-counter securities markets; types of securities; primary and secondary markets in the process of capital formation; securities price behavior; government and self-regulation of securities markets. *Prerequisites:* 11-12 and 13-14. Three hours. Mr. Wass.

207 CORPORATE FINANCE A study of the sources of financing and the efficient utilization of funds by corporations. Topics include capital budgeting, capital structure, dividend policy, and problems of financing new business ventures, large and small. *Prerequisites:* 12 and 14. Three hours. Mr. Squire.

228 CURRENT MARKETING DEVELOPMENTS Modern marketing theory and practice. Topics include: the nature of consumer changes; urban and suburban trading centers; the distribution cycle; marketing legislation; functional and institutional changes. *Prerequisite:* 122. Three hours. Mr. Greif.

242 COLLECTIVE BARGAINING The subject matter, problems, and issues of union-management relationships. The structure and functions of collective bargaining in the economy. The grievance process and arbitration. The laws of collective bargaining. *Prerequisite:* 141. Three hours. Mr. Nadworny.

243 DEVELOPMENTS IN LABOR-MANAGEMENT RELATIONS Analysis of issues in collective bargaining: impact of long-term agreements; shifting

wage and related benefits demands; impacts of shifting industrial and occupational structures on collective bargaining; interpretation of Federal labor laws in relation to collective bargaining procedures; implications, and limits, of mediation and arbitration in disputes settlement. *Prerequisite:* 242. Three hours. Mr. Nadworny.

251 PERSONNEL ADMINISTRATION Selecting and training employees; job analysis and evaluation; evaluating employees; wage and wage administration; problems of morale; human relations in the supervision of personnel. *Prerequisite:* 141. Three hours. Mr. Nadworny.

252 EXECUTIVE DECISION-MAKING Synthesis of the management and operation of a firm in terms of production, marketing, personnel, and finance; the process of decision-making; the planning and execution of policies. *Prerequisites:* 121 and 143; a course in finance, or consent of instructor. Three hours. Mr. Nadworny.

254 SCIENTIFIC MANAGEMENT AND LABOR Development of scientific management, and the reactions and relationship of organized labor to it; long range effects of scientific management on the structure and policies of industry and organized labor. *Prerequisite:* 143. Three hours. Mr. Nadworny.

256 AMERICAN BUSINESS HISTORY Evolution of firms and industries from relatively small and undifferentiated establishments to large, highly complex institutions of the present day. Selected studies in textiles, machinery, transportation, steel, coal, electric machinery, insurance, communication, retail, and others. The roles of Federal and state governments and of legislation. Developments in American management. *Prerequisite:* 143 or consent of the instructor. Three hours. Mr. Nadworny.

258 PROBLEMS OF COMMUNISM A comparative study of economic and political problems of applied communism with particular emphasis on current developments in selected Communist countries. *Prerequisites:* 11-12 and six hours of political science or six hours of European history. Three hours. Mr. Dellin.

271 AUDITING The theory and practice of auditing applicable to the work of the internal and external auditor, including auditor's responsibility, types of audits, and audit programs. *Prerequisite:* 162. Three hours. Mr. Nyquist.

272, 273 COST ACCOUNTING The nature of manufacturing costs and conventional methods of accumulating, summarizing, and interpreting them. Special problems in job order, process and standard costs. Second semester, joint and by-product costs; problems of waste and spoilage; inventory planning, capital budgeting; accounting systems including EDP; statistical methods and operations research. *Prerequisite:* 14, 272 for 273. Three hours. Mr. Nyquist.

276 C.P.A. PROBLEMS Review of questions and problems from past C.P.A. examinations, including partnerships, corporations, financial statements, auditing, cost accounting, insolvencies, receiverships, liquidations, consolidations, estates, trusts, governmental and institutional accounting methods. *Prerequisite:* 162. Three hours. Mr. Nyquist.

286 ECONOMIC ANALYSIS Analysis of demand, supply, market price under competitive conditions and monopolistic influences; the theory of income distribution. *Prerequisites:* 11-12 and one other semester course. Three hours. Mr. Wass.

288 QUALITY CONTROL The application of statistical tools to industrial problems. Topics covered include control charts, sampling plans, index numbers and measurement of trends. *Prerequisites:* 187; Mathematics 8 or 11. Three hours. Mr. Saunders.

290 THE SOVIET ECONOMY An analysis of the economic development of the USSR, its structure, performance, and direction. *Prerequisites:* 11-12; twelve additional hours in economics, political science or European history. Three hours. Mr. Dellin.

291 ECONOMIC PATTERNS AND POLICIES OF EASTERN EUROPE An area approach to the resources, organization, and domestic and foreign economic policies of the Communist countries of Eastern Europe, with special emphasis on recent changes. *Prerequisites:* 11-12; twelve additional hours in economics, political science or European history. Three hours. Mr. Dellin.

292 INTERNATIONAL ECONOMIC PROBLEMS AND POLICIES Changing patterns of the international economy; important aspects of international cooperation and conflict in the economic sphere; growth and stability on global basis; regional and interregional developments. *Prerequisite:* 11-12. Three hours. Mr. Wass.

293-294 MONEY, INCOME AND PRICES Cyclical fluctuations, problems of cyclical control, employment, price levels, and overall planning. *Prerequisite:* 201-202 or concurrent enrollment therein. Three hours. Mr. LeSourd.

295 HISTORY OF ECONOMIC THOUGHT The development of economic ideas from antiquity to modern times. The ancient, the medieval, the mercantilist. The Classical, Historical, Socialist Schools. *Prerequisites:* 286 or 201-202. Three hours. Mr. Dellin.

296 MODERN ECONOMIC THOUGHT The Marxian, the neo-classical, the marginalist, the Keynesian, and other modern developments. *Prerequisite:* 295. Three hours. Mr. Dellin.

297, 298 SEMINAR Review of recent books and periodical literature; discussions and reports on topics of contemporary interest. *Prerequisite:* permission of the department. Three hours. Staff.

300, 301 INDEPENDENT READING AND RESEARCH A course designed to meet the special research problems of graduate students. *Prerequisite:* twelve graduate credits. Credit as arranged. Staff.

329 MARKETING MANAGEMENT Integration and coordination of the marketing function; planning and developing the product; testing, branding, packaging and labeling; sales program and campaign; sales organization and management; control of sales functions. *Prerequisites:* 121; 228. Three hours. Mr. Greif.

341 MANAGERIAL ECONOMICS Techniques used in management decision-making and forward planning. Demand and cost analysis, forecasting methods, capital management, budgetary planning. *Prerequisites:* Economics 187-188 and 286; Mathematics 8 or 11. Three hours. Mr. Campagna.

342 OPERATIONS RESEARCH FOR MANAGERIAL ECONOMICS A study of the application of advanced quantitative methods to operating problems in industry. Linear and curvilinear programming; queuing theory. *Prerequisite:* 341. Three hours. Mr. Campagna.

353 BUDGET PROCEDURE AND CONTROL Principles and procedures to be applied in preparing budgets and in analyzing performance under a budgetary program. *Prerequisites:* 161, 272. Three hours. Mr. Nyquist.

367 ADVANCED ECONOMIC STATISTICS Theories and techniques of statistical analysis; probability, sampling, design of experiments, tests of statistical hypotheses, statistical estimation, regression, correlation, and related topics. *Prerequisites:* 187-188; Mathematics 8 or 12. Three hours. Mr. Saunders.

377 ADVANCED ECONOMIC THEORY Macro- and micro-economic models, advanced market structure theories, theory of games, general equilibrium, dynamic models. *Prerequisites:* 286; Mathematics 8 or 11. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

The Economics Research Center is an agency for conducting fundamental and practical research in the area of economic development and a clearing house for the compilation, analysis, and dissemination of economic information. Studies such as measurement of prices, industrial output, transportation, and other trends in the State, as well as of marketing trends, labor force, employment changes, industrial development, business location, economic growth, and allied areas in the State or region or the nation will be undertaken. The Economics Research Center is intended as a resource organization for the disciplined conduct of research as well as an established source of information for University personnel, governmental, and private groups.

Undergraduate courses:

1-2 World Economic Geography
11-12 Principles of Economics
13-14 Principles of Accounting
15, 16 Economic History of the United States
109, 110 Business Law I
111 Economics of Life Insurance
112 Property and Casualty Insurance
120 Business Law II
121 Principles of Marketing
122 Problems in Marketing
123 Personal Salesmanship
131 Sales Management
132 Fundamentals of Advertising
141 Labor Economics
143 Industrial Management
161 Intermediate Accounting
162 Advanced Accounting
163 Financial Statement Analysis
164 Basic Federal Taxes
181 Transportation
183 Economic Life and Government Control
187, 188 Elementary Statistics

• EDUCATION

J. E. Baker, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF EDUCATION

Eighteen hours of Education and Psychology; see also p. 19.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours in courses in Education numbered above 200; 12 additional hours in approved courses or six additional hours and thesis research (6 hours); a year of successful experience in teaching or in a related educational activity.

COURSES OFFERED

202 PHILOSOPHY OF EDUCATION Educational theory and philosophy past and present; contributions of leading educational philosophers; the interrelationships of education, society, and philosophy. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Miss Boller.

205 HISTORY OF AMERICAN EDUCATION History of principles and practices in American education as they relate to social, economic, political, and cultural developments. *Prerequisite:* 12 hours in Education and Psychology or a major in History. Three hours. Mr. Rippa.

211 EDUCATIONAL MEASUREMENTS The essential principles of measurement in education. Topics include measures of achievement, analysis of standard tests, construction of objective tests and inventories. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Mr. Steeves.

217 SECONDARY SCHOOL CURRICULUM Principles and problems in curriculum development. An analysis of recent curricular innovations in American secondary schools. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Mr. Rippa.

222 IMPROVEMENT OF READING INSTRUCTION Practices and techniques in reading instruction. Discussion of methods of analysis, diagnostic tests and correction of reading problems. *Prerequisite:* 12 hours in Education and Psychology including an introductory course in Reading. Three hours. Mr. Mour.

231 SECONDARY SCHOOL PRINCIPALSHIP Duties of the secondary school principal, organization and administration of the secondary school, the secondary school curriculum, pupil personnel services, problems of the teaching staff, school-community relations. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Mr. Baker.

232 SCHOOL ADMINISTRATION A general course in school administration designed for both teachers and administrators. Organization, administration, control, and financing of American public education. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Mr. Baker.

250 GUIDANCE IN EDUCATION Introduction to guidance as an organized function of education; bases of modern guidance practices; the school testing program; relationship of guidance to the curriculum; current approaches to guidance problems of the intellectually gifted; counseling techniques for classroom teachers. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Staff.

252 TEACHING LATIN A seminar that considers problems of language, literary interpretation and criticism, Roman civilization, bibliography, with allied studies helpful to prospective teachers. *Prerequisites:* Latin 102 and 112. Three hours. Mr. Kent.

255 The SCHOOL AS A SOCIAL INSTITUTION The development of a sociological perspective for the analytical exploration of selected public school practices and problems. Sociological and socio-psychological concepts and methods will be drawn from research in other institutional spheres and applied to the study of the school. *Prerequisite:* 12 hours in Education and Psychology. Three hours. Staff.

275 ANALYSIS OF READING PROBLEMS A study of group and individual clinical measures for diagnosing reading needs. Instruction and experience in administering techniques for diagnosing reading, spelling and study skills problems and recommending corrective materials and procedures. *Prerequisite:* 12 hours in Education and Psychology including a course in tests and measurements and in techniques in teaching of reading. Previous teaching experience is recommended. Three hours. Mr. Mour.

284 COUNSELING A study of the process and technique of counseling with special emphasis on the sociological and psychological bases. Counseling will be presented as a specialized form of teaching with consideration of its various techniques: interviews, group work, test interpretation, and analysis of case

material. *Prerequisite:* graduate standing, 12 hours in Education and Psychology, and a course in guidance and/or testing. Three hours. Staff.

285 INDIVIDUAL TESTING This course will concern itself with specific training in the techniques of the administration, scoring, and interpretation of individual intelligence tests suitable for application from the pre-school age through adult levels. Special emphasis will be placed on the Stanford-Binet Scale, L-M, and the Wechsler Adult Intelligence Scale. *Prerequisite:* graduate standing and 12 hours in Education and Psychology including an introductory course in testing. Three hours. Staff.

290 BASIC CONCEPTS IN MUSIC EDUCATION Disciplinary backgrounds; historical and philosophical foundations; fundamental considerations of the functions of music in the schools; development of a personal philosophy. Three hours. Mr. Keene.

291 PSYCHOLOGY OF MUSIC Psychological dimensions of tone and rhythm; the learning process in music; emotional and aesthetic response; musical ability; musical behavior and its measurement; American and European viewpoints and contributions. *Prerequisite:* 145-146 or Psychology 1 and 205. Three hours. Staff.

297, 298 PROBLEMS IN EDUCATION Individual work on a research problem selected by the student in consultation with a staff member. *Prerequisite:* 12 hours in Education and Psychology; endorsement by a sponsoring faculty member. Credit as arranged. Staff.

390 ORGANIZATION AND ADMINISTRATION OF MUSIC EDUCATION A study of the organization and administration of vocal and instrumental music in the public schools. *Prerequisite:* graduate standing in music education and teaching experience or consent of instructor. Three hours. Mr. Keene.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Thesis topic must be approved by a faculty committee. Credit as arranged. Staff.

• ADDITIONAL GRADUATE COURSES

The following courses (credits as indicated) are offered from time to time in Summer Sessions, and occasionally in the Evening Division Program. Candidates for the degree of Master of Education should plan to spend at least one Summer Session in residence. The Summer Session is normally of six weeks' duration, from the first week of July to the third week in August.

S200	The History of Arithmetic	3
S201	Administration of the Athletic Program	3
S203	Principles of Physical Education	3
S204	History of European Education	3
S205	History of American Education	3
S206	Comparative Education	3
S209	Workshop in the Education of Teachers of the Mentally Retarded	6
S210	Workshop in the Education of Teachers of the Mentally Retarded II	6
S212	Child Development (Adolescent Development)	3
S213	Statistical Methods in Education and Guidance	3
S214	The Slow Learner	3
S215	The Gifted Child	3
S216	Health Education	6
S218	Workshop in Curriculum	4
S219	Workshop in Economic Education	4
S220	Personality Development and Mental Hygiene	3
S223, 224	Reading Clinic	4
S225	Social Science Education in the Secondary School	3
S226	Conservation	6
S227	Teaching Science in the Secondary School	3
S228	Literature in the Junior-Senior High School Curriculum (Literary Criticism for Teachers)	3
S229	Communicative Arts in Secondary Schools (Teaching English in Secondary Schools)	3
S230	The Elementary School Principalship	3
S233	Elementary School Supervision	3
S234	Secondary School Supervision	3
S235	Seminar in Educational Administration (Supervision)	3
S241	Science Methods (Science for Elementary Schools)	3
S242	Modern Trends in Elementary Education	3
S243	Improvement of Reading in the Secondary School	3
S244	Social Studies in the Elementary School	3
S256	Methods and Materials in Elementary School Mathematics	3
S257	Teaching Mathematics in the Secondary Schools	3
S259	Teaching Foreign Language in the Elementary (Secondary) School	3
S260	Improvement in Teaching Bookkeeping and Business Subjects	3
S261	Seminar in Business Education	3
S262	Principles, Problems, and Trends in Business Education	3
S263	Improvement in Teaching Secretarial Subjects	3
S264	Business Education Curriculum	3
S270	Kindergarten Methods and Organization	3
S271	Laboratory Experiences in Kindergarten Education	4
S277	Seminar in Educational Psychology	3
S280	Professional Problems in Education	3
S281	Occupational Information	3

S282 Administration of the Guidance Program	3
S283 Group Testing in Guidance	3
S286 Test Interpretation for School Counselors	3
S299 Research Methods in Education	3

UNDERGRADUATE COURSES

Elementary Education

3, 4 Child and Community
113 School Music
121 Teaching Reading
134 Children's Literature
144 Methods and Materials I
145-146 Learning and Human Development
160 Methods and Materials II Elementary Schools
161 Student Teaching in Elementary Schools
170 Art for Elementary Schools

Secondary Education

15 Participation
104 Principles of Business Education
105 Teaching Business Subjects
145-146 Learning and Human Development
151-152 Music Methods and Practice Teaching
178 Secondary Methods and Procedures
181 Student Teaching in Secondary Schools

Physical Education

100 Physical Education in the Elementary Schools
116 Health Education
152 Methods of Teaching Sports
153 Methods of Teaching Dance
154 Recreational Leadership
155 Physical Education in Secondary Schools
156 History and Principles of Physical Education
158 Administration of Health and Physical Education

• ELECTRICAL BIOPHYSICS

A cooperative program offered by the Division of Biophysics (*F. J. M. Sichel, Chairman*) and the Department of Electrical Engineering (*W. Roth, Chairman*). (Cf. p. 42.)

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited Bachelor's degree in Electrical Engineering; a year course in Biology; a year course in Physical Chemistry.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301-302; twelve hours in physical sciences; additional approved courses; thesis research (6-12 hours) in the Division of Biophysics.

• ELECTRICAL ENGINEERING

W. Roth, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited Bachelor's degree in Electrical Engineering.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in Electrical Engineering, Physics, and Mathematics (18-24 hours); thesis research (6-12 hours).

COURSES OFFERED

203 ELECTRONICS II Analysis and design of wave shaping, timing and logic circuitry using solid state and vacuum tube devices. *Prerequisite:* 110. Four hours. Mr. Lambert.

204 ELECTROMAGNETIC WAVE THEORY Maxwell's equations, the Poynting vector, guided waves and radiation. Engineering applications are stressed. *Prerequisites:* 110 and Mathematics 211. Three hours. Mr. Rush.

206 U.H.F. CIRCUITS Circuits and techniques for use at ultra-high frequencies. *Prerequisites:* 203; 225. Four hours. Staff.

210 CONTROL SYSTEMS Theoretical background for analysis and synthesis of feedback control systems. Concepts of stability, transfer functions, performance criteria and compensation are viewed with root-locus and frequency response methods. Analog simulation as a design tool. *Prerequisite:* Mathematics 211 and permission of the instructor. Three hours. Mr. Taylor.

211 ELECTRIC UTILITIES Organization of the electrical utility, elementary corporate finance; economics of location, conductor size, station and line costs; rate structures; regulatory bodies. *Prerequisites:* senior standing in electrical engineering and permission of the instructor. Three hours. Staff.

214 INDUSTRIAL POWER APPLICATION Design and application of d-c and a-c motor drives for industrial plants; magnetic and electronic controls; duty cycles; acceleration, retardation and braking; power supplies and distribution systems. *Prerequisites:* 102 or 117; permission of the instructor. Three hours. Staff.

221 TRANSISTORS The fundamental principles of semi-conductor operation. P and N type conductivity; the PN junction; construction of the junction transistor. Circuit analysis of transistor operation in terms of hybrid parameters. Equivalent circuits for high frequency operation; oscillators and pulse switching circuits. *Prerequisite:* 110. Three hours. Mr. Lambert.

225, 226 CIRCUITS AND FIELDS II Study of basic laws and elementary applications of electromagnetic fields; electrostatics, magnetostatics, Faraday's

Law, plane waves, transmission lines and wave guides. *Prerequisites:* 25 and 26, 225 for 226. Three hours. Mr. Evering.

235 NETWORK SYNTHESIS Basic principles of passive electrical network synthesis; energy relations, physical realizability, two terminal network synthesis; approximation methods; properties and synthesis of four-terminal networks. *Prerequisite:* 126. Three hours. Mr. Lai.

238 RADIATION ELECTRONICS A study of electronic techniques for the detection and measurement of radioactivity; ionization chambers, geiger counters, proportional counters, scintillation counters, neutron counters, coincidence circuits, ratemeters, and scalers. *Prerequisite:* Physics 16 or permission of the instructor. Three hours. Staff.

239 TRANSIENT PHENOMENA Study of complex variable basis of Laplace and Fourier Transforms; applications to transient behavior of lumped and distributed parameter systems, root locus, Nyquist criterion and two dimensional field problems. *Prerequisite:* 126. Three hours. Mr. Rush.

241 HYBRID COMPUTERS System design concepts and use of interconnected analog and digital computers as an engineering tool are stressed. Selected problems from mathematics, biological and physical sciences are solved on a hybrid computer. The use of logic and decision as well as analog/digital and digital/analog conversion are stressed. *Prerequisite:* 110 or permission of the instructor. Three hours. Mr. Taylor.

260 SOLID STATE PHYSICAL ELECTRONICS Electrical conduction phenomena in semi-conductors; junction transistors and thermionic emitters. The ideas developed are applied to various solid state devices. *Prerequisite:* 102 or 109 or Physics 172. Three hours. Mr. Lambert.

270 INFORMATION-TRANSMISSION SYSTEMS Introduction to information transmission; modulation and demodulation; noise and noise figures; comparison of information transmission systems; transmission lines and propagation. *Prerequisite:* 126. Three hours. Mr. Roth.

272 INFORMATION THEORY Introduction to probability concepts of information theory; entropy of probability models; theoretical derivations of channel capacity; coding methods and theorems, sampling theorems. *Prerequisite:* Mathematics 21. Three hours. Mr. de la Cuesta.

281, 282, 283, 284 SEMINAR Presentation and discussion of advanced electrical engineering problems and current developments. *Prerequisite:* senior or graduate engineering enrollment. One hour. Staff.

285 CREATIVE ENGINEERING Creative techniques and problem approach to applications of these methods to current industrial problems. *Prerequisites:* Mathematics 211; at least four hours in Electricity and Magnetism or in Electrical Engineering in courses numbered above 100; permission of the instructor. Three hours. Staff.

287, 288 SPECIAL TOPICS Formulation and solution of theoretical and practical problems dealing with electrical circuits, apparatus, machines or systems. *Prerequisite:* 125. Three hours. Staff.

301 NONLINEAR SYSTEM ANALYSIS Study of the principal methods of solving nonlinear problems. Topological, analytical, graphical, and numerical methods; the general theory of nonlinear oscillation and stability; application of theory to numerous oscillatory problems. *Prerequisite:* Mathematics 211 and degree in physical sciences or engineering. Three hours. Staff.

311 ADVANCED CONTROL SYSTEMS Multiple input-output control system analysis. State space techniques, sampled-data and nonlinear control systems. Design utilizing optimal control theory. *Prerequisite:* 210, Mathematics 211, and degree in physical sciences or engineering. Three hours. Mr. Taylor.

316 POWER SYSTEMS Machine and line transients; steady state and transient stability of power systems; relay systems; circuit breakers; lighting; fault studies; coordination of power and telephone systems. *Prerequisites:* senior standing in electrical engineering and permission of the instructor. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of research topic under the direction of an assigned staff member culminating in an acceptable thesis. Credit as arranged.

Research interests of the Department of Electrical Engineering are in the areas of control systems, instrumentation, electromagnetic fields, biomedical engineering, electrical power distribution, solid state materials and devices.

Undergraduate courses:

25-26 Electric Circuits I
101, 102 Electrical Engineering Principles
109, 110 Electronics I
116, 117 Electric Machines
125 Electric Circuits II
126 Electric Circuits and Fields I

• ENGLISH

S. N. Bogorad, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major in English or its equivalent; satisfactory scores on the Graduate Record Examinations; demonstration of proficiency in writing by a detailed statement concerning the purpose in pursuing graduate study in English.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours in English; 6 additional hours in English or a related field; thesis research (6 hours); reading knowledge of a foreign language, normally French or German.

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20. Satisfactory scores on the Graduate Record Examinations are prerequisite for acceptance to candidacy for this degree.

Note: The written comprehensive examination for the degrees of Master of Arts and Master of Arts in Teaching covers both English and American literature.

COURSES OFFERED

201 CHAUCER Study of the principal works of Chaucer, with emphasis on Chaucer's literary scope, talents, and position in medieval literature. *Prerequisites:* 27, 28. Three hours. Miss Hughes.

206 ELIZABETHAN DRAMA A study of drama in England from its beginning to 1642, exclusive of Shakespeare. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mr. Long.

207-208 SHAKESPEARE Literary study and textual interpretation of most of Shakespeare's works. *Prerequisites:* 27, 28. Three hours. Miss Bandel.

209, 210 ELIZABETHAN PROSE AND POETRY The major writers of the Tudor and Stuart periods; English prose from the early humanists to the Restoration. English poetry from Wyatt and Surrey to Donne and his followers, including the development of Elizabethan lyric poetry. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Long.

212 MILTON *Paradise Lost, Paradise Regained, Samson Agonistes,* some of the minor poems, and selections from the prose works. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Bogorad.

217 RESTORATION AND EIGHTEENTH-CENTURY DRAMA English drama from Dryden to Sheridan. The literary and theatrical qualities of representative plays. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mr. Bogorad.

218 RESTORATION AND EIGHTEENTH-CENTURY PROSE AND POETRY The works, including selected novels, of significant writers from Dryden to Johnson. Particular emphasis on the development of the essay, the satires of Pope and Swift, and the works of the Johnson-Boswell circle. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mr. Bogorad.

221, 222 THE ROMANTIC PERIOD First semester: development of the Romantic Movement through Wordsworth and Coleridge; second semester: Byron, Shelley, Keats, and other Romantic poets and prose writers. *Prerequisites:* 27, 28. Three hours. Mr. Jones.

227, 228 ENGLISH NOVEL English fiction from its origins through the nineteenth century. Masterpieces are stressed and read critically. *Prerequisites:* 27, 28. Three hours. Mr. Woodruff.

231, 232 VICTORIAN LITERATURE A study of the lives and the works, except the novels, of the significant writers from 1832 to 1900. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mr. Long.

237 MODERN NOVEL Representative British and American novelists since 1915. *Prerequisites:* 27, 28. Three hours. Mr. Cochran.

238 MODERN DRAMA European and American plays which represent the principal trends in the dramatic renaissance of the late nineteenth and twentieth centuries. *Prerequisites:* 27, 28. Three hours. Miss Bandel.

239 MODERN POETRY A study of selected English and American poets since 1885, including Yeats, Eliot, and Stevens. *Prerequisites:* 27, 28. Three hours. Mr. Caswell.

240 MODERN SHORT FICTION Critical study of short stories and novellas of outstanding modern writers; recent techniques and trends. *Prerequisites:* 27, 28. Three hours. Mr. Cochran.

244 MODERN IRISH LITERATURE A study of Irish literature from 1890 to the present, with emphasis on Yeats and Joyce. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Caswell.

251, 252 AMERICAN NOVEL Masterpieces of nineteenth-century American fiction selected on the basis of literary merit. Lectures, class discussions, oral and written reports. First semester: Hawthorne, Melville, and others; second semester: Mark Twain, Howells, James, and others. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mr. Trevithick.

253 AMERICAN COLONIAL LITERATURE Intellectual and literary origins of American culture, with emphasis on the works of Edwards, Taylor, Franklin, Woolman, Hamilton, and Jefferson. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Trevithick.

254 EMERSON, THOREAU, AND THEIR CIRCLE Special attention to the essays, journals, and poetry of Emerson, and to Thoreau's *Walden.* Minor writers in the group will receive briefer treatment. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Trevithick.

256 LITERATURE OF THE AMERICAN FRONTIER Frontier, local-color, and regional writing in America from the eighteenth century to the First World War, including Parkman, Harte, Mark Twain, Garland, and others. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Cochran.

258 AMERICAN POETRY Major American poets from the eighteenth century to the First World War, including Poe, Whitman, Dickinson, Robinson, Frost, and others. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67.

259 HISTORY OF THE ENGLISH LANGUAGE The principles of historical linguistics and their application to English. *Prerequisites:* 27, 28. Three hours. Alternate years, 1966-67. Mrs. Clark.

260 STRUCTURE OF THE ENGLISH LANGUAGE Descriptive study of the structure of modern American English. *Prerequisites:* 27, 28. Three hours. Mrs. Clark.

261 OLD ENGLISH The sounds, words, and structure of Old English; simple prose texts and selections from *Beowulf.* *Prerequisites:* 27, 28. Three hours. Offered at irregular intervals; not offered in 1965-66.

271 BIBLIOGRAPHY Methods of literary study, research, and scholarship. *Prerequisites:* 27, 28. Three hours. Mr. Pope.

272 HISTORY OF CRITICISM Principles and theories of criticism from Aristotle to the twentieth century. *Prerequisites:* 27, 28. Three hours. Alternate years, 1965-66. Mr. Orth.

273 TECHNIQUE AND CRITICISM OF POETRY Poetic theory, with close analysis of selected poems to show their organic structure, the relation between poetic effect and sense, mood, tone, imagery, stanzaic form, and meter. *Prerequisites:* 27, 28. Three hours. Mr. Bogorad.

275, 276 CONTEMPORARY CRITICISM A seminar in selected topics of contemporary critical interest (for example, myth and tragedy); discussion and criticism of selected major works, both contemporary and traditional. *Prerequisites:* 27, 28. Three hours. Mr. Strandberg.

277-278 ADVANCED CREATIVE WRITING The development of extended projects in creative writing such as a novel, a group of short stories or plays, or a sequence of poems. *Prerequisites:* 27, 28; either 16 or 18. Three hours. Mr. King.

281 SEMINAR FOR PROSPECTIVE TEACHERS OF ENGLISH Grammar and language; literary interpretation and criticism; allied problems useful to teachers of English. *Prerequisites:* 27, 28; and 260. Three hours. Miss Hughes.

302 GRADUATE SEMINAR A seminar for graduate students only. The topic varies from year to year, depending on the faculty member assigned to the course. Recommended for all first-year graduate students in English. Three hours.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

The research interests of the faculty of the Department of English and the library resources for research enable graduate students to undertake thesis subjects in virtually all the fields represented by the course offerings of the Department.

Undergraduate courses:

1-2 Freshman English
16 Expository Writing
18 Creative Writing
27, 28 Sophomore Literature
102 Medieval Literature in Translation
133, 134 Development of American Literature
135, 136 Canadian Literature
192 Major Concepts in English Literary History

• FORESTRY

W. R. Adams, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Successful completion of a four-year Forestry curriculum or a strong Forestry undergraduate major.

MINIMUM DEGREE REQUIREMENTS

Forestry 381, 382; advanced related courses (9 hours); thesis research (15 hours).

COURSES OFFERED

205 MINERAL NUTRITION OF PLANTS This course is identical with Plant and Soil Science 205, see p. 102.

208 BIOLOGICAL STATISTICS The application of statistics to the analysis of biological data. Interpretation of statistical analysis. *Prerequisite:* Mathematics 9. Three hours. Mr. Post.

252 FOREST VALUATION Principles and methods of appraisal of forest land, growing stock and other forest resources. Damage appraisals. *Prerequisite:* 136 and 151 or concurrent enrollment. Two hours. Staff.

282, 284 SEMINAR Review and discussion of current research literature. Required of Forestry seniors and graduate students. One hour. Staff.

381, 382 SPECIAL TOPICS Review and discussion of assigned forestry research literature. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Investigations at the Vermont Research Forest include the development of management plans for native and exotic conifers adapted to sandy soils; the effect of micro-weather and other site factors and stand density upon tree growth; provenance tests of exotic conifers; and the utilization and marketing of small and inferior tree species.

Other investigations include the relationship between soil and other site factors and tree growth of planted conifers and natural seeded commercial native hardwoods throughout Vermont; influence of soil and other site factors, nutrition, and cultural practices on Christmas tree quality; volume table construction for native timber species; and the marketing of forest products by timberland owners and wood processors. Cooperation in Northeastern Regional Research in forest tree improvement, and forest oriented recreation.

Undergraduate courses:

1 Introduction to Forestry
3, 4 Dendrology
24 Foundations of Silviculture
32 Forest Fire Control
41, 42 Forest Mensuration I, II
100 Forestry Problems
103-104 Woodland Management
122 Silvics
123 Silviculture
130 Forest Management Planning
133 Forest Recreation Management
136 Forest Management
140 Forest Mensuration III
142 Forest Photogrammetry
151 Forest Economics
152 Forest Policy
161 Wood Technology
163 Timber Harvesting and Milling
164 Forest Products
171 Principles of Wildlife Management
172 Practice of Wildlife Management
197, 198 Senior Research
222 Advanced Silviculture
232 Watershed Management

• FRENCH

M. D. Daggett, Chairman [Romance Languages]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major in French, including a year course in literature and a year course in advanced composition and conversation.

MINIMUM DEGREE REQUIREMENTS

French 381, 382; additional courses in French; an advanced course in another literature (6 hours); thesis research.

A program is also offered leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

203, 204 FRENCH LITERATURE: TWENTIETH CENTURY Principal literary movements from 1900 to the present, with emphasis on outstanding works in the novel, drama, and poetry. *Prerequisites:* 101-102; 203 for 204. Three hours. Mr. Johnston.

211 FRENCH LITERATURE: EIGHTEENTH CENTURY Main currents of the literature of the century, with emphasis on Montesquieu, Diderot, Voltaire and Rousseau. Lesage, Marivaux, and Beaumarchais will be studied in the drama. *Prerequisite:* 101-102. Three hours. Alternate years, 1965-66. Mr. Johnston.

213 FRENCH LITERATURE: SEVENTEENTH CENTURY Selected works of the century, with emphasis on Corneille, Molière and Racine. *Prerequisite:* 101-102. Three hours. Alternate years, 1966-67. Mr. Julow.

216 FRENCH LITERATURE SIXTEENTH CENTURY Selected works of the period, with emphasis on Rabelais, Montaigne, and the Pléiade. *Prerequisite:* 101-102. Three hours. Alternate years, 1966-67. Mr. Daggett.

217 SPECIAL STUDIES IN FRENCH LITERATURE Selected authors representative of French thought and literary merit. *Prerequisite:* 101-102. Three hours. Alternate years, 1965-66. Mr. Johnston.

223-224 ADVANCED COMPOSITION AND CONVERSATION Translation into French of difficult English prose; free composition and discussion of questions of style. Practice in advanced conversation. Required of those who wish to be recommended to teach French. *Prerequisite:* 121-122. Three hours. Mr. Daggett.

227, 228 LINGUISTIC STRUCTURE OF FRENCH. An analysis of present day French, with emphasis on phonetics, phonemics, morphology, and syntax of the language. Considerable language laboratory practice is expected. Required for all who seek certification for teaching. *Prerequisites:* 121-122 and junior standing; 227 for 228. Three hours. Mr. Dennis.

381, 382, 383, 384 SEMINAR Offered for resident candidates for the Master of Arts degree; further opportunities for independent work are provided. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Thesis reseach in French literature is limited to the periods from the seventeenth century on, with special emphasis on the twentieth century.

Undergraduate courses:

1-2 Elementary French
11-12 Intermediate French
101-102 French Literature: Nineteenth Century
121-122 Composition and Conversation

• GEOGRAPHY

E. J. Miles, Chairman

No Master's degree program offered.

257 POLITICAL GEOGRAPHY The characteristics of the political unit as a geographic area: location, resources, and the distributional relationships of the variety of cultural or human factors as they have a bearing on the structure and functioning of the modern political unit. The relationship between geopolitics and political geography. *Prerequisites:* 12 hours in geography and political science, or permission of instructor. Three hours. Mr. Miles.

201 HISTORICAL GEOGRAPHY OF THE UNITED STATES An examination of the physical setting within which the drama of American history has unfolded. Emphasis is placed on the sequence of peoples and cultures which have occupied the land and on their varied appreciation of its resource base. *Prerequisites:* History 23 or 28 plus 9 additional hours in geography, history, or other social science. Three hours. Mr. Miles.

• GEOLOGY

R. S. Stanley, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in Geology, year courses in Chemistry, Physics or Biology, and Mathematics. Open to undergradute majors in physics, chemistry, biology, engineering or mathematics who have accumulated 20 semester hours in geology.

MINIMUM DEGREE REQUIREMENTS

Thesis and advanced courses in Geology must total at least thirty semester hours. Advanced courses in related sciences may be substituted for some selected Geology courses on approval by the department chairman. A reading knowledge of an approved foreign language is required.

A program is also offered leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

211 X-RAY CRYSTALLOGRAPHY The theory and practice of X-ray powder diffraction techniques for the identification of crystalline materials; single crystal methods and X-ray spectrography. *Prerequisites:* junior or senior

standing with a concentration in a physical science, engineering, or mathematics. Three hours. Mr. Grant.

215 GEOMORPHOLOGY The land forms of the surface of the earth and their origins; external and internal forces modifying the earth. The physiographic provinces of North America. *Prerequisites:* 106, 116 or concurrent enrollment therein. Three hours. Alternate years, 1966-67. Staff.

216 GLACIAL GEOLOGY The origin, mechanics and effects of past and present glaciations. *prerequisite:* 215. Three hours. Alternate years, 1966-67. Staff.

224 STRATIGRAPHY The sequential development and distribution of the sedimentary rocks. *Prerequisites:* 106, 116. Three hours. Alternate years, 1965-66. Mr. Hunt, Mr. Stanley.

242 FOREIGN REGIONAL GEOLOGY An examination and comparison of the geology of selected portions of the world. *Prerequisites:* 106, 116. Three hours. Alternate years, 1966-67. Mr. Stanley, Mr. Doten.

251 GEOLOGY OF ORE DEPOSITS The origins and geologic associations of ore deposits. The classification and structure of such deposits and the application of physical and chemical methods for their discovery. *Prerequisite:* 106. Three hours. Alternate years, 1965-66. Mr. Doten.

281, 282, 283, 284 SEMINAR IN GEOLOGY A synthesis of geologic processes and evolution of North America and selected portions of the world. Topics cover a wide range of subjects, with emphasis on current problems. *Prerequisites:* 106, 115, 116. One hour. Staff.

312 ADVANCED MINERALOGY Selected topics in mineralogy including crystal chemistry experimental mineralogy, and current problems in mineralogy. *Prerequisite:* 211. Three hours. Alternate years, 1966-67. Mr. Grant.

321 IGNEOUS GEOLOGY Paragenesis of igneous rocks; laboratory work on selected suites of specimens. *Prerequisite:* 106. Three hours. Alternate years, 1966-67. Mr. Doten.

324 METAMORPHIC GEOLOGY The origin of metamorphic rocks with emphasis on the concepts of metamorphic facies, analysis and interpretation of mineral assemblages, and the spacial relationship of metamorphism to tectogenesis. *Prerequisites:* 106, 211. Three hours. Alternate years, 1965-66. Mr. Stanley, Mr. Grant.

326 SEDIMENTARY PETROLOGY Origin and interpretation of sedimentary rocks. Topics include mechanics of transportation and deposition, recent depositional environments, interpretation of surface textures, methods of statisti-

cal analysis, theoretical aspects of rock classification, and sedimentary tectonics. Thin section study and individual projects. *Prerequisites:* 106. Three hours. Mr. Hunt.

335 ADVANCED STRUCTURAL GEOLOGY The geometric relationship and origin of various structural features in the different tectonic environments of the earth's crust. Emphasis is placed on field investigations, laboratory results, and theoretical models that provide insight into the deformational behavior of rocks in different parts of the earth's crust and the relationship between geologic structure and the dynamic configuration in which they have formed. *Prerequisite:* 116. Three hours. Mr. Stanley.

342 ADVANCED PALEONTOLOGY Problems in biogeology, paleoecology, and stratigraphic paleontology. The use of fossils in determining the origin, depositional environment, and age of rocks. Consideration is given to biogenic sedimentation, to taxonomic, adaptive, and biogeographic methods of paleoecological interpretation, and to geochronologic measures. *Prerequisite:* 121. Three hours. Mr. Hunt.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Research programs are oriented in the following areas: Selected problems in mineralogy including meteorites; selected problems in igneous and metamorphic petrology and ore genesis; sedimentary and metamorphic stratigraphy of New England and nearby areas; structural geology of sedimentary, metamorphic, and igneous terrains, including structural analysis of strain features of various sizes; petrofabric studies of strain features in selected minerals; geologic history and recent sedimentation of Lake Champlain; evolution, ecology and ontogeny of invertebrate fossils; ground water and surficial geology.

Undergraduate courses:

1-2 Introductory Geology
11-12 Mineralogy
21 Geology for Engineers
105, 106 Petrology
115 Field Geology
116 Structural Geology
121 Paleontology
130 Geology of Mineral Resources
197, 198 Research in Geology

• GERMAN

J. F. White, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major in German, including a year course in literature and a year course in advanced composition and conversation or the equivalent.

MINIMUM DEGREE REQUIREMENTS

German 381, 382; additional courses in German; advanced courses in a related field (6 hours); thesis research (6-12 hours).

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

205, 206 GOETHE Life and works of the poet through the Italian journey (205). Goethe in the years of his maturity: 1790-1832 (206). *Prerequisite:* 101-102 or the equivalent. Three hours. Alternate years, 1965-66. Messrs. Webster and White.

207 NINETEENTH CENTURY PROSE Masterpieces of narrative prose by representative authors such as Mörike, Keller, O. Ludwig, C. F. Meyer, Stifter, Raabe and the early Thomas Mann will be read. *Prerequisite:* 101-102 or the equivalent. Three hours. Alternate years, 1966-67. Mr. White.

208 NINETEENTH CENTURY DRAMA Works by Kleist, Büchner, Grillparzer, Hebbel, O. Ludwig, Wagner and the early Hauptmann will be read. *Prerequisite:* 101-102 or the equivalent. Three hours. Alternate years, 1966-67. Mr. White.

209, 210 THE TWENTIETH CENTURY Selected works in poetry, prose and drama by Brecht, George, Hauptmann, Hofmannsthal, Kafka, Thomas Mann, Rilke, and others will be read. *Prerequisite:* 101-102 or the equivalent. Three hours. Alternate years, 1967-68. Mr. White.

221-222 ADVANCED COMPOSITION AND CONVERSATION Guided conversation, discussion and advanced oral and written drill in German. Study of modes of expression and stylistic devices of modern German based on analysis of selected texts. Problems in translating literary and technical English prose into German. *Prerequisite:* 121-122 or equivalent. Three hours. Mr. Kahn.

232 HISTORY OF THE GERMAN LANGUAGE Introduction to Germanic linguistics, the comparative method, and linguistic reconstruction. The linguistic development of German from Indo-European to the present. No knowledge of older stages of the language is presupposed or required. *Prerequisite:* 121-122 or the equivalent. Three hours. Mr. White.

235 THE STRUCTURE OF GERMAN Linguistic analysis of the phonological, morphological, and syntactic structure of modern German with special attention to problems useful for teachers. *Prerequisite:* 121-122 or the equivalent. Three hours. Mr. White.

281-282 SEMINAR Special readings and research. One hour. Staff.

381, 382 GRADUATE SEMINAR Readings, conferences, and reports in connection with the work of candidates for the Master's degree. Credit as arranged. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Current research interest in the Department of German concerns the linguistic structure of German; history of the German language; medieval German literature; literature of the eighteenth, nineteenth and twentieth centuries; the modern novel; and stylistics.

Undergraduate courses:

1-2 Elementary German
11-12 Intermediate German
81-82 Scientific German
101-102 Introduction to German Literature
121-122 Composition and Conversation

• GREEK

J. H. Kent, Chairman [Classics]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Eight semesters of Greek or their equivalent; a year course in Latin; a course in Greek History; a reading knowledge of French, German, or Modern Greek.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours of advanced courses in Greek; 6 additional hours in Greek, Latin, History, or Philosophy; thesis research (6 hours).

A program is also offered leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

201 GREEK ORATORS Selected speeches of Lysias and Demosthenes. *Prerequisite:* 11-12. Three hours. Alternate years, 1965-66. Mr. Kent.

202 GREEK COMEDY Two plays of Aristophanes. *Prerequisite:* 11-12. Three hours. Alternate years, 1965-66. Miss Davison.

203 GREEK HISTORIANS Thucydides, Books I and II; selections from Herodotus and Xenophon's *Hellenica*. *Prerequisite:* 11-12. Three hours. Alternate years, 1966-67. Mr. Kent.

204 GREEK TRAGEDY Sophocles' *Antigone* and Euripides' *Medea*, or two equivalent plays. *Prerequisite:* 11-12. Three hours. Alternate years, 1966-67. Mr. Ambrose.

205 GREEK PHILOSOPHERS Plato, *Republic*, Books I and II; selections from the Pre-Socratics and from Aristotle. *Prerequisite:* 11-12. Three hours. Alternate years, 1965-66. Mr. Ambrose.

252 GREEK EPIGRAPHY Introduction to Greek inscriptions, with emphasis on those of historical interest. *Prerequisite:* 201 or 203. Three hours. Alternate years, 1966-67. Mr. Kent.

381, 382 SEMINAR Intensive study at the graduate level of Greek authors not read in the candidate's undergraduate program. Credit as arranged. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Current research interests in Greek include Early Greek Literature; the Attic orators; Greek drama; archaeology (especially epigraphy and pottery); Mycenaean and Homeric Greece; Hellenistic economics.

Undergraduate courses:

1-2 Elementary Greek
11-12 Intermediate Greek
111-112 Greek Prose Composition
151 Greek Drama in Translation
153 Greek Historians in Translation

• HISTORY

R. V. Daniels, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major in history, or in a related field of the social sciences or humanities with the equivalent of a minor in history. Competency in a foreign language as appropriate to the student's intended program.

Applicants must take the Graduate Record Examination (aptitude and advanced history), and submit a sample independent research paper or term paper written in the course of undergraduate study.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours in History, including thesis research (six hours); six additional hours in History or a related field.

The Department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

(Note: All graduate courses have the prerequisite of a specified survey course plus six additional hours of history or other social science. The first semester of any two-semester course is a prerequisite for the second semester, except by permission of the instructor.)

201 HISTORICAL GEOGRAPHY OF THE UNITED STATES This course is identical with Geography 201, see p. 69.

203, 204 LATIN-AMERICAN HISTORY Political, social, and economic development. First semester, colonial period; second semester, national period. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Felt.

211 THE RENAISSANCE Political, economic, and cultural developments in Europe, 1250-1517, with emphasis on Italian humanism. *Prerequisite:* 11 and 12, or 13, or 33 and 34. Three hours. Prof. Evans.

212 THE REFORMATION Political, economic, and cultural developments in Europe in the sixteenth century. Particular attention will be devoted to the religious movements, and to the evolution of Northern European humanism. *Prerequisite:* 11 and 12, or 13. Three hours. Staff.

213, 214 CANADIAN HISTORY Canadian development from the French exploration and settlement to the present; evolution of self-government and relations with the United States; historical foundations of the problems of biculturalism. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Metcalfe.

221, 222 THE AMERICAN COLONIES American history to 1789. *Prerequisite:* 11 and 12, or 13, or 23 and 24, or 28. Three hours. Mr. Stout.

231, 232 FRENCH HISTORY History of France in modern times: first semester, seventeenth century to 1848; second semester, 1848 to the present. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Newhall.

233, 234 GERMAN HISTORY History of Germany in modern times: first semester, seventeenth century to 1850; second semester, 1850 to the present. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Schmokel.

241, 242 ERA OF THE FRENCH REVOLUTION AND NAPOLEON French history from 1789 to 1815 with special attention to the impact of French ideas and power upon Europe. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Evans.

243 SOVIET RUSSIA The USSR from the Revolution of 1917 to the present. This course is intended as a general introduction to the study of Russia and Communism, including: historical and ideological background, Soviet political and economic institutions, Soviet foreign policy and international Communism. *Prerequisite:* 11 and 12, or 13, or 51 and 52. Three hours. Mr. Daniels.

244 TSARIST RUSSIA History of Russia from the Middle Ages to the Revolution of 1917, with emphasis on the period since Peter the Great. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Daniels.

253, 254 ENGLISH HISTORY Political and social history of England and its role in world history. First semester, Middle Ages to 1715; second semester, 1715 to the present. *Prerequisite:* 11 and 12, or 13. Three hours. Mr. Spinner.

257, 258 AMERICAN STATESMEN Thought and practical politics of American statesmen. *Prerequisite:* 23 and 24, or 28. Three hours. Mr. Schultz.

261 VERMONT HISTORY *Prerequisite:* 23 and 24, or 28. Three hours. Mr. Bassett.

265, 266 AMERICAN SOCIAL AND INTELLECTUAL HISTORY Selected topics in the social and intellectual history of the United States since 1783. *Prerequisite:* 23 and 24, or 28. Three hours. Mr. Felt.

267, 268 HISTORY OF U. S. FOREIGN RELATIONS International relations from the eighteenth century to the present, with major emphasis on the foreign policies of the United States. First semester 1763-1893; second semester 1893-present. *Prerequisite:* 12, 13, 24, or 28. Three hours. Mr. Berger.

277 GOVERNMENT OF THE USSR Theoretical background, structure and development of the Soviet state and the Communist Party; economic, social, and cultural policies; comparative survey of other Communist governments; current changes. *Prerequisite:* 243, or six hours of Political Science including 72. Three hours. Mr. Daniels.

278 FOREIGN POLICY OF THE USSR Theoretical background; history of Soviet foreign relations; development of the international Communist movement and the Communist bloc; factors and instruments of policy; current problems of relations between Russia and the West and among the Communist countries. *Prerequisite:* 243 or six hours of Political Science including 51. Three hours. Mr. Daniels.

281, 282, 283, 284 SEMINAR Advanced study in a selected field. The Department offers seminars in the fields of American, European, and Ancient History. *Prerequisite:* 18 hours of history and permission of the department. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of an individual research topic. Required of all candidates for the MA. Normally arranged for two semesters at three hours each. Staff.

Research interests in the History Department include American history of the colonial, early federal, Civil War, and twentieth-century periods; American social and legal history; American relations with Latin America; Vermont history; the Renaissance; French history (French Revolution, Third Republic); English history (Tudor and recent); twentieth-century German and Russian history; the Communist movement and Soviet foreign policy; Canadian history; African history; European economic history; history of science, especially physics in the seventeenth and twentieth centuries. For ancient history, see Latin and Greek. For modern China, see Political Science.

Undergraduate courses:

1 Introduction to European History
11, 12 European Civilization
13 European Thought and Institutions
23, 24 History of the United States
28 American Thought and Institutions
31, 32 Ancient History
33, 34 Medieval Europe
40 Biography
51, 52 Contemporary History
61, 62 History of Science
71, 72 Asian Civilization
116 Introduction to African History
123 American History since 1945
130 Chinese History

• HOME ECONOMICS

B. Williams, Chairman

The department offers programs leading to the degree of Master of Science in the fields of Food and Nutrition and Family Economics, and also a more general program leading to the degree of Master of Arts in Teaching and degree of Master of Extension Education: Cf. pp. 20 and 21.

Food and Nutrition

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in Food and Nutrition or equivalent.

MINIMUM DEGREE REQUIREMENTS

Twenty hours major credit may be chosen from advanced courses in Foods, Nutrition, Biochemistry or related fields; thesis research (6-15 hours); minor credits up to ten hours.

Family Economics

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Basic courses in Home Economics, Economics, and Mathematics.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in Family Economics, Economics, and related fields (15-24 hours); thesis research (6-15 hours); and Statistical Methods, unless offered for admission.

COURSES OFFERED

203 HOME MANAGEMENT PROBLEMS Application of economic and sociological principles to some problems of the home and family. *Prerequisites:* 101; Economics 12; Psychology 1. Three hours. Miss Knowles.

204 FAMILY ECONOMICS The consumer and the market, use of credit, savings and investments, insurance and estate planning for the family. *Prerequisites:* 101 or equivalent, Economics 12. Three hours. Miss Knowles.

206 ADVANCED HOUSING Investigation of housing data and current problems including studies of environmental factors, technological developments and governmental programs. *Prerequisites:* 51, Economics 12 and Sociology 21. Three hours. Miss Knowles.

216 TEACHING ADULTS Problems of organization and of teaching classes in home economics to meet the needs of adults; supervised experience in techniques of teaching adults. *Prerequisites:* 165; either Education 145, 146 or Agricultural Education 100. Two hours. Miss Brown.

221 COSTUME DESIGN AND DRAPING Analysis of current fashion. Development of original design by draping techniques. *Prerequisites:* 73, 120. Three hours. Miss Caldwell.

230 HOME FURNISHINGS II Studies in interior design with special emphasis given to period furnishing, its present use and influence upon modern furnishing. *Prerequisite:* 130. Three hours. Miss Caldwell.

236 INTRODUCTION TO FOOD RESEARCH Methods and techniques used in experimental work in foods. Independent laboratory study of problems in food preparation. *Prerequisite:* 135. Three hours. Miss Williams.

242 RECENT ADVANCES IN FOOD AND NUTRITION Interpretation, application and communication of the recent trends in Foods and Nutrition as evidenced through current literature and research. *Prerequisites:* 43, 135, 137 or equivalent; Chemistry 1 and 2, or 3 and 4. Three hours. Staff.

243 ADVANCED NUTRITION The principles of human nutrition; the value of foods with application in calculating food requirements and diets for children, adults and family groups. *Prerequisites:* Agricultural Biochemistry 201; Zoology 52. Four hours. Miss Morse.

244 DIET THERAPY The adaptations of the normal diet in conditions affected by or affecting the utilization of food. *Prerequisite:* 243. Three hours. Miss Wakefield.

246 READINGS IN FOODS A critical survey of the literature on the recent developments in food research. *Prerequisites:* 135; Agricultural Biochemistry 201. Two or three hours. Staff.

248 READINGS IN NUTRITION A critical survey of the literature on recent developments in nutrition. *Prerequisite:* 243 or permission of instructor. Two or three hours. Staff.

263 SEMINAR IN FAMILY RELATIONS AND HUMAN DEVELOPMENT Theory and research on the family. *Prerequisites:* 63, 163 and Sociology 51. Three hours. Alternate years, 1965-66. Mr. Samenfink.

264 THE AMERICAN WOMAN Focuses on recent literature regarding the role of women and the unique tasks they face in maintaining stability in a dynamic 20th century world. *Prerequisite:* 163 and Sociology 51. Three hours. Alternate years, 1966-67. Mr. Samenfink.

265 FAMILY LIFE EDUCATION IN THE SCHOOL AND COMMUNITY Practical and theoretical approach to the family as an interacting unit and as an institution. Teachers, social workers, nurses, guidance and extension specialists and others, are offered an opportunity to develop a philosophy basic to family life education. *Prerequisites:* 63, 163, or equivalent. Three hours. Mr. Samenfink.

266 PERSONALITY AND DEVELOPMENT IN EARLY CHILDHOOD An intensive study and application of the principles of child development in relationship to preschool education, nursing and other areas. *Prerequisite:* 63 and 163 or equivalent. Three hours. Mr. Samenfink.

273 RELATED ART, TEXTILES AND CLOTHING SEMINAR Theory and research in the field of Clothing, Textiles and Related Art; analysis of current problems; review and discussion of recent research, books and publications; individual studies. *Prerequisites:* 182, 221, 230 or equivalent. Three hours. Staff.

288 INSTITUTIONAL MARKETING Advanced course in institutional management. Units on advanced management, marketing, accounting, equipment, floor plans, layouts and related material on design and furnishings in the different types of food services. *Prerequisites:* 186, 187. Four hours. Alternate years, 1965-66. Miss Wakefield.

294 HISTORY OF NUTRITION Foremost investigators and methods involved in the development of present day nutritional knowledge. *Prerequisites:* three hours of nutrition. One hour. Miss Morse, and Messrs. Donovan and Smith.

296 NUTRITION SEMINAR A review of the recent developments in human nutrition in reference to the individual and to the nutritional problems on a world-wide basis. *Prerequisite:* a college course in principles of nutrition. Two to three hours. Staff.

297, 298 PROBLEMS IN EDUCATION—HOME ECONOMICS This course is identical with Education 297, 298, see p. 57.

301 READINGS IN FAMILY ECONOMICS Critical survey of the literature and of recent research in Family Economics. *Prerequisites:* 204. Statistical Methods and one other advanced Economics course (may be taken concurrently). Three or four hours. Staff.

307 ADVANCED CONCEPTS IN NUTRITION This course is identical with Poultry Science 307, see p. 107.

308 EXPERIMENTAL TECHNIQUES IN NUTRITION This course is identical with Animal and Dairy Science 308, see p. 39.

370 ADVANCED HOME ECONOMICS EDUCATION A study of recent trends, philosophy and objectives in methods of teaching homemaking at the secondary school level. Opportunity will be provided for individuals to work on problems related to their own situations. *Prerequisites:* 165, degree in Home Economics, teaching experience. Three hours. Miss Brown.

386, 387 GRADUATE SEMINAR Designed for graduate students concentrating in the department. Advanced study in a special field; opportunities for independent work are provided. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Research in Foods and Nutrition may include work on controlled diet experiments, basic human nutrition, nutritional status studies and food analysis.

Research in Family Economics may be in the analysis of family income and spending patterns, the determining of household production and consumption factors and other related fields.

Undergraduate courses:

20 Introduction to Textiles and Clothing
21 Design
22 Clothing Selection and Construction
43 Basic Concepts of Food and Nutrition
51 Housing
54 Household Equipment
61 The Family, Community and Preschool
63 Human Development and Personality
65 Experience with Preschool Children
67 Creative Activities
71 Costume Design
73 Pattern Design and Advanced Construction
101 Principles of Home Management
105 Experimental Equipment
106 House Planning
110 Early Childhood Education
113 Social Welfare as a Social Institution
114 Social Welfare as a Profession
115 Introduction to Home Economics Education
120 History of Costume
123 Tailoring
130 Home Furnishings I
135 Advanced Food Preparation
137 Meal Management
139 Food Service Management
144 Applied Normal Nutrition
153 Home Management Residence
160 Preschool Practicum
162 Social Work in the Community
163 Dynamics of Family Development
164 Introduction to Parent Education and Family Consulting
165 Methods of Teaching
166 Special Problems in Home Economics Education
168 Student Teaching
169 Communication Methods
182 Advanced Textiles
186 Quantity Food Production
187 Institutional Administration
238 World Dietary Problems
291, 292 Special Problems

• LATIN

J. H. Kent, Chairman [Classics]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major or its equivalent in Latin; a course in Roman History; a reading knowledge of French, German, or Italian.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours of advanced courses in Latin; 6 additional hours in Latin, Greek, History, or Philosophy; thesis research (6 hours); one year of Greek (if not completed as an undergraduate).

A program is also offered leading to the Degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

203 REPUBLICAN PROSE Extensive reading in Caesar and Sallust, and in the speeches of Cicero. *Prerequisite:* 101-102. Three hours. Mr. Gilleland.

204 EPIC POETS Extensive reading in Lucretius, Vergil, Ovid, and others. *Prerequisite:* 101-102. Three hours. Mr. Ambrose.

223 ADVANCED PROSE COMPOSITION *Prerequisite:* 112. Three hours. Mr. Pooley.

251 ROMAN LETTERS Selected letters of Cicero, Pliny and Fronto. *Prerequisite:* 203, 204 or concurrent enrollment therein. Alternate years, 1965-66. Mr. Gilleland.

252 COMEDY Two plays of Plautus and Terence. Study of the precursors of this literary form. *Prerequisites:* 203, 204 or concurrent enrollment therein. Three hours. Alternate years, 1965-66. Mr. Pooley.

253 ROMAN ORATORY Selections from Cicero's *De Oratore, Orator,* and *Brutus,* and from his speeches. Historical development of forensic and other rhetorical canons. *Prerequisite:* 203, 204 or concurrent enrollment therein. Three hours. Alternate years, 1966-67. Mr. Gilleland.

255 HISTORIANS OF THE EMPIRE Augustus, *Res Gestae;* Tacitus, *Annals,* I-IV; selections from Suetonius and Ammianus Marcellinus. *Prerequisites:* 203, 204, or concurrent enrollment therein. Three hours. Alternate years, 1966-67. Mr. Kent.

256 SATIRE Selections from Horace and Persius; Juvenal, *Satires* I, III, X. Study of the development of this literary form. *Prerequisites:* 203, 204, or concurrent enrollment therein. Three hours. Alternate years, 1966-67. Mr. Kent.

271 SILVER LATIN Extensive reading of post-Augustan authors not included in other advanced courses. *Prerequisites:* 203, 204, and 6 additional hours in courses numbered above 200. Three hours. Alternate years, 1965-66. Mr. Gilleland.

381, 382, 383, 384 SEMINAR Intensive study at the graduate level of Latin authors not read in the candidate's undergraduate program. Credit as arranged. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Current research interests in Latin include Cicero's rhetorical works; Lucretius; Caesar; the Roman conquest of Greece; Roman provincial administration; Latin epigraphy; Etruscology.

Undergraduate courses:

1-2 Elementary Latin
11-12 Intermediate Latin
32 Etymology
101-102 Survey of Latin Literature
111-112 Latin Prose Composition
152 Roman Epic in Translation
154 Roman Satire in Translation

• MATHEMATICS

N. J. Schoonmaker, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Thirty semester hours beyond intermediate calculus, including a year of advanced calculus.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours in advanced Mathematics courses; thesis research (6 hours).

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

207, 208 ADVANCED CALCULUS The calculus beginning with limits, continuity, differentiation, and Riemann integrals; treatment of those topics not included in the earlier course as a foundation for more advanced courses in analysis and applied mathematics. *Prerequisites:* 102; 207 for 208. Three hours. Staff.

209 PROJECTIVE GEOMETRY The principle of duality, perspectivity, projectivity, harmonic sets, cross ratio, the theorems of Pascal and Brianchon, poles and polars. *Prerequisite:* 12. Three hours. Alternate years, 1966-67. Staff.

210 FOUNDATIONS OF GEOMETRY Geometry as an axiomatic science; various non-Euclidean geometries; relationships existing between Euclidean

plane geometry and other geometries; invariant properties. *Prerequisite:* 12. Three hours. Staff.

211 DIFFERENTIAL EQUATIONS Solutions of linear ordinary differential equations, the Laplace transformation, and series solutions of differential equations. *Prerequisite:* 21. Three hours. Staff.

212 APPLIED MATHEMATICS I Boundary-value problems; orthogonal functions; vector analysis. *Prerequisites:* 24 and 211. Three hours. Mr. Dwork.

213 APPLIED MATHEMATICS II Partial differential equations and their solutions applied to mathematical physics; the functions of a complex variable. *Prerequisite:* 212. Three hours. Mr. Dwork.

214 APPLIED MATHEMATICS III Calculus of variations; difference equations; integral equations. *Prerequisite:* 213. Three hours. Mr. Dwork.

220 VECTOR ANALYSIS Introduction to vector methods, including the elements of vector algebra and vector calculus, with applications to physics and mechanics. *Prerequisite:* 21. Three hours. Staff.

225, 226 TOPOLOGY The elements of point set topology: closed sets and open sets in metric spaces, continuous mappings, connection, Peano curves, separation theorems and homotopy. *Prerequisites:* 102; 225 for 226. Three hours. Alternate years, 1966-67. Staff.

227 DIFFERENTIAL GEOMETRY Analytic metric differential geometry of curves and surfaces in ordinary three dimensional space; curvature, torsion, Frenet formulas, involutes, evolutes, developable and ruled surfaces, geodesic curves. *Prerequisite:* 21. Three hours. Alternate years, 1965-66. Staff.

228 NUMBER THEORY Divisibility, prime numbers, Diophantine equations, congruence of numbers, and methods of solving congruences. *Prerequisite:* 21. Three hours. Staff.

231, 232 FUNCTIONS OF A COMPLEX VARIABLE Differentiation and integration of a function of a complex variable, mapping of elementary functions, infinite series, properties of analytic functions, analytical continuation, calculus of residues, contour integration, integral functions, meromorphic functions, Riemann surfaces, and conformal representation. *Prerequisites:* 208; 231 for 232. Three hours. Alternate years, 1966-67. Staff.

233, 234 THEORY OF FUNCTIONS OF REAL VARIABLES Point sets and measure, transfinite numbers, Riemann and Lebesgue integrals, and sequences of functions. *Prerequisites:* 208; 233 for 234. Three hours. Alternate years, 1965-66. Staff.

235, 236, 237 SPECIAL TOPICS IN ANALYSIS For advanced students in the field of analysis. Lectures, reports and directed readings on advanced topics in analysis. *Prerequisites:* 232 or 234 and consent of instructor. Credit as arranged. Offered as occasion warrants. Staff.

241, 242 MODERN HIGHER ALGEBRA Fundamental concepts of abstract algebra. Sets, mappings, groups, rings, integral domains, fields, homomorphisms, isomorphisms, linear transformations and vector spaces. *Prerequisites:* 12; 241 for 242. Three hours. Staff.

243 THEORY OF GROUPS The study of the various kinds and structures of groups. *Prerequisite:* 241. Three hours. Alternate years, 1965-66. Staff.

244 GALOIS THEORY The study of Galois theory leading to the insolvability of general quintic equations by radicals and theorems on constructions with ruler and compasses. *Prerequisite:* 243. Three hours. Alternate years, 1965-66. Staff.

245, 246, 247 SPECIAL TOPICS IN ALGEBRA For advanced students in the field of algebra. Lectures, reports and directed readings on advanced topics in algebra. *Prerequisites:* 241 and consent of instructor. Credit as arranged. Offered as occasion warrants. Staff.

251 THE THEORY OF DIGITAL COMPUTING MACHINES AND NUMERICAL ANALYSIS Mathematical theory underlying digital computing machines including assigned problems on the IBM 1620, and 7094 at M.I.T., including programming in machine language, symbolic and fortran languages. The last third of the course is devoted to elementary numerical analysis. *Prerequisite:* 21; 24 highly desirable. Three hours. Staff.

252 ADVANCED NUMERICAL ANALYSIS Finite difference methods, numerical solutions of differential equations, numerical solutions of systems of linear equations, linear programming and approximations of various types. Problems solved on the 1620 computer. *Prerequisites:* 251 and credit or concurrent enrollment in 24. Three hours. Alternate years, 1966-67. Staff.

255, 256, 257 SPECIAL TOPICS IN GEOMETRY For advanced students in the field of geometry. Lectures, reports and directed readings on advanced topics in geometry. *Prerequisites:* 209 or 227 and consent of instructor. Credit as arranged. Offered as occasion warrants. Staff.

265, 266, 267 SPECIAL TOPICS IN TOPOLOGY For advanced students in the field of topology. Lectures, reports and directed readings on advanced

topics in topology. *Prerequisites:* 226 and consent of instructor. Credit as arranged. Offered as occasion warrants. Staff.

270, 271 ORDINARY DIFFERENTIAL EQUATIONS Linear and nonlinear systems, approximate solutions, existence, uniqueness, stability, asymptotic behavior of solutions. *Prerequisites:* 208 or consent of instructor; 270 for 271. Three hours. Mr. Chamberlain.

275, 276 FUNCTIONAL ANALYSIS L^2 spaces and L^P spaces, Hilbert and Banach spaces, linear functionals and linear operators, completely continuous operators, Fredholm alternative, completely continuous symmetric operators, Hilbert-Schmidt theory, unitary operators, Bochner's Theorem, Fourier-Plancherel and Watson transforms. *Prerequisites:* 234; 275 for 276. Three hours. Staff.

281 THROUGH 286 SEMINAR Members of the staff and approved students meet weekly to study contemporary advances in mathematics and for reports on current research. One hour. Staff.

291 PROBABILITY THEORY Permutations and combinations, probability, stochastic variables, discrete and continuous distribution, joint distributions, binomial, Poisson and normal distributions, moments, measures of central tendency and of variability. *Prerequisite:* 12. Three hours. Staff.

292 MATHEMATICAL STATISTICS Sampling distributions, testing hypotheses, use of chi-square, Student's t and F distributions in significance tests, point and interval estimation, regression and correlation. *Prerequisite:* 291. Three hours. Staff.

293 ADVANCED MATHEMATICAL STATISTICS Sampling theory, analysis of variance, regression and correlation analysis, multiple correlation, analysis of covariance, nonparametric test. *Prerequisite:* 292. Three hours. Staff.

294 DESIGN OF STATISTICAL EXPERIMENTS Experimental design, analysis of experimental models and decision processes. *Prerequisite:* 293 or consent of instructor. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Current research interests in the Department of Mathematics include applied mathematics; computer theory; foundations of mathematics; infinite series; linear programming; modern algebra; real variables; statistics; probability; topology; game theory and differential equations.

Undergraduate courses:

2 Plane Trigonometry
4 Mathematics of Finance
7, 8 Fundamentals of Mathematics
9 College Algebra
11 Plane Analytic Geometry and Calculus
12 Analytic Geometry and Calculus
21 Sophomore Mathematics
24 Linear Algebra
102 Fundamental Concepts of Mathematical Analysis

• MECHANICAL ENGINEERING

J. O. Outwater, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited Bachelor's degree in Mechanical Engineering, or its equivalent, including either Mechanical Engineering 262 and 266, or 252.

MINIMUM DEGREE REQUIREMENTS

Mathematics 212; Electrical Engineering 210; Mechanical Engineering 202; *either* Mechanical Engineering 243, 244 and 267 *or* Mechanical Engineering 211, 222, 272; additional approved courses; thesis research.

At the present time a two-year period is required for completion of the Master's degree program.

COURSES OFFERED

202 ADVANCED MECHANICS Development of the foundations of mechanics leading to Hamilton's principle and LaGrange's equations; vibration and stability of systems with many degrees of freedom; gyroscopic effects in mechanical systems; systems with variable coefficients and non-linear systems. *Prerequisite:* 252. Three hours. Mr. Carpenter.

211 ADVANCED MECHANICAL STRUCTURES I The torsion problem and membrane analogy; thick cylinders and rotating discs; beams on elastic foundation and the bending of cylindrical shells; creep. *Prerequisites:* 252; Mathematics 211. Three hours. Mr. Carpenter.

222 ADVANCED MECHANICAL STRUCTURES II Stress and strain at a point in three dimensions; the theory of elasticity with two-dimensional examples; development of strain energy method with applications to beams, curved bars and plates; elastic bodies in contact. *Prerequisite:* 211. Three hours. Mr. Outwater.

243 ADVANCED FLUID MECHANICS Foundations of fluid dynamics; thermodynamics and concepts of compressible flow; isentropic flow; normal shock waves; flow in ducts with friction and with heating or cooling; generalized solution of combined effects. *Prerequisites:* 142 and Mathematics 211. Three hours. Mr. Duchacek.

244 COMPRESSIBLE FLOW Introduction to flow in two and three dimensions; steady irrotational flow; small pertubations; the hodograph method; the Karman-Tsien, Prandtl-Glauert, and Gothert's methods; supersonic airfoils; the method of characteristics; oblique shocks; shock waves and boundary layer interaction. *Prerequisite:* 243. Three hours. Mr. Duchacek.

246 AERODYNAMICS Application of the principles of fluid mechanics to the design and performance of aircraft; fluid dynamics; experimental facilities; airfoil characteristics; aspect ratio and plan-form influences; viscosity phenomena as applied to boundary layer; transition and separation on various shapes; compressibility phenomena; the optimum airfoil; performance. *Prerequisite:* 142. Three hours. Mr. Duchacek.

252 MACHINE DESIGN II A continuation of 135 with emphasis on the dynamics and vibration of machines. Design problems correlating various engineering fundamentals and considering practical limitations. *Prerequisites:* 52, 135. Four hours. Mr. Carpenter.

262 ADVANCED HEAT POWER ENGINEERING Application of theoretical thermodynamic cycles to actual plant and machine; analysis of the elements of internal combustion engines, gas turbines, and steam power plants; investigation of nuclear and other energy sources; development of station energy balances; economic factors. *Prerequisites:* 111 or 113, 266. Four hours. Mr. Tuthill.

266 HEAT TRANSFER Fundamental principles of heat transfer; conduction, convection, radiation; steady and unsteady state; the electric analogy; applications to heat transfer equipment. *Prerequisites:* 111 or 113; Mathematics 211. Three hours. Mr. Duchacek.

267 ADVANCED THERMODYNAMICS A rigorous, detailed study of the laws of thermodynamics and of ideal and actual thermodynamic processes. *Prerequisites:* 111 or 113, Mathematics 211. Three hours. Mr. Tuthill.

271 INDUSTRIAL MATERIALS I Fundamentals of ferrous and non-ferrous physical metallurgy, and non-metallic materials. The correlation of the microscopic structure and physical properties of metals, alloys and plastics with their heat treatments and uses. *Prerequisites:* Chemistry 2; Physics 16. Three hours. Mr. Outwater.

272 MECHANICAL BEHAVIOR OF MATERIALS Elastic and plastic behavior of single crystals and polycrystals; dislocations; approximate plastic analysis; anisotropic materials; hardness; residual stress; brittle, transitional and ductile fractures; fatigue; damping; creep and surface phenomena. *Prerequisite:* 271. Three hours. Mr. Outwater.

274 INDUSTRIAL MATERIALS II Geometrical Crystallography; packings in crystals; formation and transformations in crystals; structure of metals,

semiconductors, and insulators. Some laboratory work will be required. *Prerequisite:* 271. Three hours. Mr. Outwater.

284 ADVANCED HEAT ENGINES Application of engineering science to specific types of heat engines according to the interest of the students. *Prerequisites:* 111, 142, 266. Three hours. Staff.

301 ADVANCED MACHINE DESIGN Advanced mechanics of materials and applications to mechanical design according to the interests of the students. *Prerequisite:* 251. Three hours. Mr. Carpenter.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Research in the department of Mechanical Engineering includes: mechanical properties of glass, glass-resin interaction in reinforced plastics, failure mechanisms in composite materials, deep submergence problems, residual stresses in welded plates, high temperature creep problems, mechanical forces on the human body—their measurement and implications, and instrumentation and test methods for material properties and processing variables.

Undergraduate courses:

51, 52 Manufacturing Processes
84 Mechanical Instrumentation
92 Thermodynamics I
111 Thermodynamics II
113 Thermodynamics and Heat Transfer
132 Mechanisms
135 Machine Design I
142 Fluid Mechanics
164 Air Conditioning
174 Industrial Engineering
175 Motion and Time Study
176 Plant Organization

• MEDICAL MICROBIOLOGY

F. W. Gallagher, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

One year of biological science; Mathematics 12 or equivalent; Physics 5 and 6 or equivalent; Chemistry 1 and 2, 123, 131 and 132 or equivalent.

MINIMUM DEGREE REQUIREMENTS

Medical Microbiology 201; Microbiology 381-384; Thesis Research; Medical Biochemistry 301, 302, 303-304 (At the discretion of the Department other biochemistry courses may be substituted); enough credits from the following courses to complete thirty credit hours: Advanced Agricultural Biochemistry 250 and 253; Medical Microbiology 312, 322 and 324; or appropriate courses in Mathematics, Physics or Chemistry.

For another Master's program in this field, see under Microbiology.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY*

One year of organic chemistry, one year of biology, and sufficient Mathematics and Physics to provide background for the candidate's program. One year of residence and passage of a general examination in Microbiology.

MINIMUM DEGREE REQUIREMENTS

Agricultural Biochemistry 253; Medical Microbiology 201, 312, 322 and 324, and 381-389. Language requirements as described on page 23.

Course requirements may be completed by electing from the following: graduate courses offered by the preclinical departments of the College of Medicine; and courses numbered 200 or more offered by the Departments of Agricultural Biochemistry, Botany, Chemistry, Mathematics, Physics and Zoology.

A minimum of twenty hours and a maximum of thirty-five hours for thesis research will be allowed for the degree.

COURSES OFFERED

201 MEDICAL MICROBIOLOGY The fundamentals of microbiology; general principles of infection and resistance to infection; a systematic study of the various groups of disease producing microorganisms. *Prerequisite:* permission of the Department. Seven hours. Staff.

301 SPECIAL PROBLEMS IN BACTERIOLOGY Minor investigations in Bacteriology designed to serve as an introduction to research. *Prerequisite:* 201. Two hours. Staff.

302 SPECIAL PROBLEMS IN IMMUNOLOGY Minor investigations in Immunology designed to serve as an introduction to research. *Prerequisite:* 201. Two hours. Staff.

312 GENETICS OF MICROORGANISMS Current theories of the chemical nature of genetic materials, the structure of the gene, gene action, allelism, crossing over, mutagenesis and cytoplasmic inheritance will be discussed in the light of recent contributions from the field of microbiology. Techniques developed for the study of microbial genetics will be emphasized. *Prerequisite:* Permission of the instructor. Three hours. Alternate years, 1965-66. Mr. Suriano.

322 IMMUNOLOGY A one-semester course designed to provide the student with a comprehensive theoretical and practical knowledge of immunity and immunochemistry. *Prerequisite:* permission of the instructor. Two hours. Alternate years, 1966-67. Mr. Tokuda.

324 IMMUNOLOGY LABORATORY *Prerequisite:* Permission of the instructor. One hour. Alternate years, 1966-67. Mr. Tokuda.

381-389 SEMINAR Discussion of current problems and literature in the field. *Prerequisite:* Permission of the department. One hour per semester. Staff.

* Program operated jointly with the Department of Microbiology.

391-399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491-499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable Doctoral dissertation. Credit as arranged.

Research Activities of the Department of Medical Microbiology are in microbial physiology; microbial genetics; pathogenic bacteriology; immunology; and virology.

• MICROBIOLOGY

D. B. Johnstone, Chairman [Agricultural Biochemistry]

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in science, including an undergraduate course in Bacteriology and Chemistry 131-132.

MINIMUM DEGREE REQUIREMENTS

Agricultural Biochemistry 201, 250, 253; Medical Microbiology 201, 381-384; thesis research (10-15 hours).

For another Master's program in the field of Microbiology, see under Medical Microbiology.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY*

One year of organic chemistry and biology and sufficient mathematics and physics to provide background for the candidate's program. One year of residence and passage of General Examination in microbiology.

MINIMUM DEGREE REQUIREMENTS

Medical Microbiology 201, 312, 322, and 324; Agricultural Biochemistry 253; the balance of courses according to student's need as determined by a studies committee; participation in microbiology seminars throughout residency, a reading knowledge of German and French or Russian; doctoral thesis research twenty to thirty-five hours.

Microbiological research in the Department of Agricultural Biochemistry is concerned with the biochemistry of microbial syntheses: antibiotics, carbohydrate polymers, pigments and aquatic pesticide degradation. It involves fluorescence, nitrogen fixation, and heavy water and employs electrophoresis, chromatography, and infrared spectrophotometry.

* Program offered jointly with Medical Microbiology.

• MUSIC

F. W. Lidral, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

An approved undergraduate major in Music or Music Education; satisfactory performing ability in an applied music area; satisfactory score on the Graduate Record Examination.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours in Music; participation in musical ensembles throughout the term of residence; thesis research (6 hours); a reading knowledge of German, French, or Italian.

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

COURSES OFFERED

201, 202 ADVANCED HARMONY AND HARMONIC ANALYSIS Contemporary harmonic practice and sonority organizations; traditional and contemporary analysis. *Prerequisite:* 105-106; 201 for 202. Three hours. Alternate years, 1966-67. Mr. Kinsey.

203, 204 ORCHESTRATION First semester: The characteristics of instruments: arranging for orchestra; second semester: advanced exercises in orchestral scoring. *Prerequisites:* 105-106; 203 for 204. Three hours. Mr. Pappoutsakis. 204 in alternate years, 1965-66.

205, 206 COUNTERPOINT First semester: tonal counterpoint; second semester: canon and fugue. *Prerequisites:* 105-106; 205 for 206. Three hours. Mr. Kinsey. 206 in alternate years, 1965-66.

207 PEDAGOGY OF THEORY Objectives, viewpoints, content, and specific approach to organization and the teaching of theory courses. *Prerequisite:* 18 hours in Theory. Three hours. Mr. Lidral. Alternate years, 1965-66.

208 FORM AND ANALYSIS Creative approach to aural and sight analysis of musical construction. *Prerequisites:* 105-106; 205 recommended. Three hours. Mr. Lidral.

209, 210 ARRANGING, VOCAL AND INSTRUMENTAL First semester: arranging for vocal ensembles of various sizes and functions including mixed groups, men's and women's glee clubs, and chamber groups; second semester: arranging for instrumental ensembles of various sizes including marching, concert, and school bands, and chamber groups. *Prerequisite:* 203. Three hours. Messrs. Lidral and Schultz. Alternate years, 1966-67.

211, 212 CONDUCTING First semester: technique of the baton, score reading, laboratory practice; second semester: preparation and performance of

selected scores, including score reading at the piano and rehearsal procedures. Selected students will conduct university major ensembles. *Prerequisites:* 5-6; 211 for 212. Three hours. Mr. Pappoutsakis. 212 in alternate years, 1966-67.

215, 216 COMPOSITION Creative work in free composition with instruction according to the needs and capabilities of the individual student. *Prerequisite:* 205 and 208 or consent of instructor. Three hours. Mr. Lidral.

221, 222 HISTORY OF MUSIC Changes in musical structure and style, in relation to contemporaneous artistic, literary, religious, and social movements. First semester: Gregorian chant to the Baroque era; second semester: Baroque to Modern. *Prerequisites:* 1, 2 and 5-6. Three hours. Mr. Bennett.

223, 224, 225, 226, 227, 228 MUSIC LITERATURE Advanced studies in the literature of music. *Prerequisites:* 105-106 and 221, 222. Three hours. Messrs. Bennett and Lidral.

245, 246 CHAMBER MUSIC LITERATURE Study through analysis and performance of masterworks for small groups leading to public performance. *Prerequisite:* 12 hours or the equivalent in applied field and consent of instructor. One hour. Staff.

251, 252 ADVANCED INDIVIDUAL STUDY Private study in keyboard instruments, voice, strings, woodwinds, brass, percussion, and harp leading to public recital performance. *Prerequisite:* Advanced standing in applied field. One or two hours. Staff.

271, 272 APPLIED MUSIC PEDAGOGY Methods of teaching voice, strings, woodwinds, brass or keyboard instruments and advanced class instruction in them. Research paper required. *Prerequisite:* Performing ability, teaching experience, and consent of instructor. Staff.

281, 282, 283, 284 INDEPENDENT STUDY Studies in theory, composition, history, or literature, under the direction of an assigned staff member for advanced students and candidates for honors. Credit as arranged.

381, 382, 383, 384 SEMINAR Study of special topics appropriate to student needs. One hour. Mr. Kinsey.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Research in the Department of Music traditionally includes stylistic study and analysis of selected works with emphasis on structural organization. Graduate research is also conducted in the areas of historical studies, music education, development of performance techniques and pedagogy, and Americana.

Undergraduate courses:

1, 2 Survey of Musical Literature
5-6 Theory I
9, 10 Introductory Music
41, 42 Major Ensembles
45, 46 Chamber Music
51, 52 Individual Study (Applied)
71, 72 Class Study (Applied)
74 Instrument Repair Class
105-106 Theory II
112 Choral Literature
113 Vocal Literature

• PATHOLOGY

R. W. Coon, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Anatomy 301, 311, 322; Physiology and Biophysics 301-302; Biochemistry 301, 302.

MINIMUM DEGREE REQUIREMENTS

Pathology 301-302 (13 hours), Medical Microbiology 201 (7 hours), additional approved courses; thesis research (6-15 hours).

COURSES OFFERED

201 HISTOCHEMISTRY A survey of techniques used for chemical identification of cellular and tissue components, including discussion of underlying theories. *Prerequisite:* an acceptable course in cell structure (*e.g.*, Anatomy 311, Botany 256); Chemistry 131-132; permission of the department. A course in biochemistry is strongly recommended. Credit as arranged. Not offered each year.

301-302 GENERAL AND SPECIAL PATHOLOGY The processes of injury inflammation, repair, neoplasia, etc.; diseases of the various organ systems. Similar to the course for second-year medical students except that it does not include work in clinical pathology. *Prerequisite:* permission of the department. Credit for the complete course is thirteen hours; by special arrangement, qualified graduate students may enroll for 301 only, with credit hours to be arranged.

310, 311, 312 ADVANCED PATHOLOGY Supervised practical experience in handling, processing, and diagnosis of pathological materials. Participation in departmental seminars and conferences. *Prerequisite:* 301-302; permission of department. Credit as arranged.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

The research interests of the Department of Pathology are in the fields of anatomic, clinical and experimental pathology. Current studies include histo-

chemistry, blood coagulation, extra corporeal heart pumps, diseases of the perinatal period, reproductive physiology and pathology, biochemistry and pathology of connective tissue, immunology, and electron microscopy.

• PHARMACOLOGY

D. J. Smith, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Chemistry 131-132; Physics 5-6; Mathematics 11-12; a year course in Biology; additional supporting courses in science; a reading knowledge of a foreign language, preferably German.

MINIMUM DEGREE REQUIREMENTS

Pharmacology 301-302, 381, 382; supporting courses in Biochemistry and Physiology; thesis research (6-15 hours).

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Mathematics 21; Chemistry 131-132 and 141-142; Physics 14-15; a year course in a biological science; a reading knowledge of German and of one other appropriate foreign language. Cf. also p. 16.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301-302; Biochemistry 301, 302, 303-304; Pharmacology 301-302; 381 through 384; advanced courses in Pharmacology; at least ten additional hours in courses other than Pharmacology; doctoral thesis research (20-30 hours). Cf. also p. 23.

COURSES OFFERED

301-302 MEDICAL PHARMACOLOGY The basic mechanism of action of therapeutic agents, their pharmacological actions, their fates and toxicology. *Prerequisite:* permission of the department. Six and two hours. Staff.

311, 312 PHARMACOLOGICAL TECHNIQUES Demonstration and laboratory exercises in selected procedures of pharmacological research, with special emphasis upon the cardiovascular system and neuropharmacology. *Prerequisites:* Pharmacology 301-302 or Physiology and Biophysics 301-302. Two hours. Staff.

320 DRUG METABOLISM A study of the manner by which absorption, distribution, metabolism and excretion alter drug activity. Recent developments in analytical methods employed in such studies are included. *Prerequisite:* 301-302. Two hours. Staff.

362 DRUG EVALUATION Techniques employed in the study of a new chemical agent from its initial synthesis to its release to the medical profession. *Prerequisite:* 301-302. Two hours. Staff.

372, 374, 376 SPECIAL TOPICS IN PHARMACOLOGY Topics of current interest and importance in pharmacology are considered in depth through presentations by graduate students and staff. During each year a specific theme of study will be developed. *Prerequisite:* Permission of the department. One hour. Staff.

381, 382, 383, 384 SEMINAR General and specific considerations of current developments and research in pharmacology are presented for critical discussion by students, staff and visiting scientists. *Prerequisite:* permission of the department. Two hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable doctoral dissertation. Credit as arranged.

The research program of the Department of Pharmacology covers several areas. Studies of the basic physiology and pharmacology of the central and autonomic nervous systems and cardiovascular system are emphasized. Chemotherapeutic agents, which might be effective against cancer and various microorganisms (such as trypanosomes) are being studied with the emphasis upon their biochemical mechanism of action. Drug distribution and metabolic studies are accomplished utilizing the most advanced radioactive isotope techniques. Studies on the influence of drugs upon liver function are being conducted. A large Cobalt-60 source is used for study of both the physiology of radiation damage and drugs capable of protecting mammals against the effects of ionizing radiation.

• PHILOSOPHY AND RELIGION

R. W. Hall, Chairman

No Master's degree program offered

PHILOSOPHY

COURSES OFFERED

201 CONTEMPORARY PHILOSOPHIC THOUGHT A study of the philosophic ideas of such men as Russell, Dewey, and Whitehead, and of such movements as pragmatism, logical empiricism and existentialism. *Prerequisites:* 1; junior standing. Three hours. Mr. Beckett.

206 SOCIAL PHILOSOPHY The meanings and values inherent in social life. *Prerequisites:* 1 or 4; junior standing. Three hours. Mr. Hall.

214 INTELLECTUAL BACKGROUND OF MODERN LIFE Intellectual movements which have influenced the thought and life of today. *Prerequisites:* senior standing; permission of the department. Three hours. Mr. Dykhuizen.

215 PLATO A systematic analysis of the Dialogues of Plato on the following topics: theory of knowledge, ethics and political philosophy, and fine art. *Prerequisites:* two courses in philosophy or permission of the instructor. Students concentrating in the Classics may be admitted. Three hours. Mr. Hall.

281, 282 READINGS IN PHILOSOPHY Selected classics in philosophical literature. The choice of classics will be determined according to the interest of students and instructor. *Prerequisites:* one year of advanced courses in philosophy or consent of the instructor. Three hours each semester. Staff.

Members of the Department are prepared to give guidance in research in the following fields: History of Philosophy, Ethics, Social Philosophy, Aesthetics, and Logic.

Undergraduate courses:

1 Introduction to Philosophy
2 Logic
4 Ethics
81 Symbolic Logic
82 Philosophy of Science
102 Philosophy of Religion
107, 108 History of Philosophy
109 Recent American Philosophy
113 Aesthetics

RELIGION

201 METHODS OF UNDERSTANDING RELIGION A systematic investigation of some of the major methodological contributions to the understanding and interpretation of religion since Tylor and Frazer. The course will conclude with an analysis of the contemporary phenomenological movement and its contribution to the methodology of religion. *Prerequisites:* Religion 1, 2. Three hours. Mr. Paden.

205, 206 AREA STUDIES IN RELIGION A study in depth of religion in a particular area of the modern world such as: the Indian sub-continent, Japan, the Middle East, Latin America. *Prerequisites:* 6 hours in Religion or consent of the instructor. Three hours each semester. Staff.

211 CONTEMPORARY TRENDS Significant modern developments in the world religions. *Prerequisites:* Religion 1, 2. Three hours. Mr. Kim.

281, 282 PROBLEMS IN THE HISTORY AND PHENOMENOLOGY OF RELIGION Topics of special concern to historians of religions. *Prerequisites:* Religion 201 or consent of the instructor. Three hours each semester. Staff.

Members of the Department are prepared to give guidance in research in the following fields: History of Religions, Phenomenology of Religion, and Methodology of Religion.

Undergraduate courses:

1, 2 Religions of the World
11 Bible
101 Religion and Society
112 Religious Experience
122 Myth and Ritual

• PHYSICS

A. D. Crowell, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in Science, Engineering or Mathematics; Physics 115, 116; two additional semester courses in physics above the sophomore level; two semester courses in mathematics above the sophomore level; satisfactory scores in the Graduate Record Examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Twelve hours in Physics courses numbered above 200 including six hours in courses numbered above 300; thesis research; a reading knowledge of an approved foreign language.

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

In addition to the general prerequisites of the Graduate College and satisfactory scores on the Graduate Record Examination, the following courses must be completed: Physics 212, 242 and 272, at least one year of general chemistry and four semester courses in mathematics beyond Mathematics 21. The student will also be required to take a departmental qualifying examination. The student's record shall be such as to convince the department of his ability to cope with graduate courses and to conduct scientific research.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Of the minimum of 40 credit hours earned in courses and seminars as established by the Graduate College, at least twenty must be in Physics and at least 12 in other disciplines. The courses Physics 311, 313, 314, 361, 362, 375 are required of all students. Candidates for the doctoral degree for work in Physics may select either of the language options in German, French or Russian. In accord with the general policy of the Graduate College, all doctoral students are required to participate in the department's undergraduate teaching program.

COURSES OFFERED

212 MECHANICS AND WAVE MOTION Applications of the principles and methods of mechanics to continuous media (solids, liquids and gases); elasticity, hydrodynamics and wave propagation. *Prerequisites:* 116; Mathematics 211. Three hours. Mr. Sachs.

222 ADVANCED BIOLOGICAL PHYSICS Sound and electromagnetic waves, the latter including light, micro-waves and x-rays; ionizing particles and radiation. Interaction of these physical agents with biological systems. Physical properties of macromolecules and their aggregates. *Prerequisites:* Chemistry 2; Mathematics 21; and experience in applying differential equations. Departmental permission required. Four hours. Mr. Nyborg.

225, 226, 227 SPECIAL TOPICS IN BIOLOGICAL PHYSICS For research students in the field of biological physics. Lectures, reports and directed readings related to the research of the department. *Prerequisite:* Mathematics 21 and consent of the department. Credit as arranged. Offered as occasion warrants. Mr. Nyborg.

231, 232, 233 SPECIAL TOPICS IN ACOUSTICS For research students in the field of acoustics. Lectures, reports and directed readings on problems of particular interest to the current research of the department. *Prerequisite:* 212 and consent of the department. Credit as arranged. Offered as occasion warrants. Messrs. Sachs and Nyborg.

242 ELECTROMAGNETISM The fundamental principles of electric and magnetic fields. Electrostatic theory and magnetic fields of steady currents. Electromagnetic energy relationships and introduction to electromagnetic theory. *Prerequisites:* 115; Mathematics 211. Four hours. Mr. Crowell.

251, 252, 253 SPECIAL TOPICS IN THE PHYSICS OF SURFACES For research students in the field of surface chemistry and physics. Background of particular interest to the current research of the Department is presented and discussed. *Prerequisites:* 173 or Chemistry 142 and Mathematics 212 and consent of the department. Offered as occasion warrants. Mr. Crowell.

271, 272 ADVANCED MODERN PHYSICS Relativity, electron physics, atomic structure and spectra, wave mechanics; molecular and solid state physics, X-rays, nuclear physics. *Prerequisites:* 116 or Electrical Engineering 110 or Chemistry 142; Mathematics 211; 271 for 272. Four hours. Mr. Juenker.

276 SOLID STATE PHYSICS Introduction to crystal structure and classification of solids. Mechanical, thermal and electromagnetic properties of solids. Free electron model of conductors and band theory. *Prerequisites:* 212, 242 and 271; Mathematics 212 or 220. Three hours. Mr. Foley. Alternate years, 1965-66.

281, 282, 283, 284 SEMINAR Members of the staff and students meet once a week to study contemporary advances in physics and to report on current research. *Prerequisite:* permission of the department. No Credit.

301, 302 MATHEMATICAL PHYSICS—Introduction to basic mathematical methods of theoretical physics; vector and tensor analysis, partial differential equations, orthogonal functions, complex variables and variational techniques

presented with appropriate physical illustrations. *Prerequisites:* 212 and 242, or Mathematics 213. Three hours. Mr. Krizan.

311 ADVANCED DYNAMICS Classical Mechanics presented as the basis of the concepts and methods of modern physics. Variational methods. Lagrangian and Hamiltonian formulations, canonical transformations. *Prerequisite:* 212. Three hours. Mr. Nyborg.

313 ELECTROMAGNETIC THEORY Development of Maxwell's theory of electromagnetism with emphasis on the unity of electric and magnetic phenomena, both in their physical basis and in the mode of mathematical description. Boundary value problems in electrostatics, multipoles, electrostatics of macroscopic media, dielectrics, magnetostatics, time varying fields, Maxwell's equations, conservation laws, gauge transformations, wave equations, Green's functions are employed throughout. *Prerequisites:* 242; Mathematics 212 or 220. Three hours. Mr. Krizan. Alternate years, 1965-66.

314 CLASSICAL ELECTRODYNAMICS A continuation of electromagnetic theory. Plane electromagnetic waves, wave guides and resonant cavities, simple radiating systems and diffraction, magnetohydrodynamics and plasma physics, special theory of relativity, relativistic particle kinematics and dynamics, Multipole fields. *Prerequisite:* Physics 313. Three hours. Mr. Krizan.

361, 362 QUANTUM MECHANICS Mathematical and physical foundations of non-relativistic quantum mechanics are presented from the unifying point of view of Dirac which includes the matrix and wave formulations. Applications include the theory of angular momentum, perturbation theory, the theory of radiative transitions and scattering theory. The role of symmetry operations and the essential algebraic structure of quantum mechanics are emphasized. *Prerequisites:* 212, 242, 272; 361 for 362. Three hours. Mr. Scarfone. Alternate years 1966-67.

363 ADVANCED QUANTUM MECHANICS Introduction to the mathematical and physical concepts of relativistic quantum mechanics and quantum field theory. Topics include Dirac theory of the electron, quantization of fields and its particle interpretation, invariance properties and selection rules, S-matrix theory, quantum-electrodynamics. *Prerequisite:* 362. Three hours. Mr. Scarfone. Alternate years. 1965-66.

375 KINETIC THEORY AND STATISTICAL MECHANICS Review of thermodynamics. Elements of kinetic theory including the Boltzmann equation, H theorem and transport phenomena. Introduction to equilibrium statistical mechanics, both quantum and classical. *Prerequisites:* 173, 272. Three hours. Mr. Krizan.

376 STATISTICAL MECHANICS Applications of fundamentals of statistical mechanics to quantum and classical ideal and imperfect gases. Investigations of special topics such as the Ising model, relativistic statistical mechanics,

physical adsorption and phase transitions. *Prerequisites:* 375 and 361. Three hours. Mr. Krizan.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable doctoral dissertation. Credit as arranged.

The Department of Physics offers opportunities for both experimental and theoretical research. An active program in acoustics includes studies of the mechanics of nonlinear sound propagation, and of changes (physical, chemical and biological) produced by high amplitude sound on structures and rates of processes. Studies of the liquid state are also being conducted by ultrasonic methods.

Research in the physics of metals includes studies of the interaction of gas molecules with metal surfaces using ultra high vacuum, radiotracer, work function and thin film techniques. In addition investigations of the optical properties of metals and the mechanisms of photoelectric emission are being conducted.

Opportunities for theoretical research in the statistical mechanics of interacting molecules near solid surfaces are available. Other studies in statistical mechanics include problems in plasma physics and relativistic corrections to statistical mechanics.

There is an active theoretical research program in relativistic and non-relativistic quantum mechanics emphasizing the study of solvable particle models and scattering theory.

Opportunities for collaborative research with other departments of the University, such as Chemistry and Physiology and Biophysics are also available.

Undergraduate courses:

5-6 Elementary Physics
14-15 General Physics
16 Introductory Modern Physics
115 Electricity and Magnetism
116 Mechanics
122 Biological Physics
161 Optics
173 Thermal Physics
191, 192 Senior Research

• PHYSIOLOGY AND BIOPHYSICS

F. J. M. Sichel, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Year courses in Biology, Chemistry and Physics.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301-302; other graduate courses as arranged (3 hours minimum); thesis research (6-15 hours).

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

One year of Biology; Chemistry 131-132; Physics 14-15; Mathematics 12, 21. A reading knowledge of French or German is recommended. Cf. also p. 16.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301-302, additional approved courses, amounting to a total of at least 16 hours in the Department, and at least 16 hours in courses offered by departments other than Physiology and Biophysics; thesis research, 20 hours; a reading knowledge of two appropriate foreign languages. Cf. also p. 23.

COURSES OFFERED

301-302 PHYSIOLOGY AND BIOPHYSICS Function in the whole human organism, and at the cellular, tissue, and organ levels, considered biologically and physically. *Prerequisite:* permission of the department chairman. Two times six hours. Staff.

303, 304, 305, 306 SPECIAL PROBLEMS IN PHYSIOLOGY Various problems are covered by means of lectures, reports and directed reading. *Prerequisite:* 301-302; permission of the department chairman. Credit as arranged. Staff.

321, 322 CELLULAR PHYSIOLOGY AND BIOPHYSICS Fundamental physical and physicochemical properties of living cells. The reading of original scientific papers in the area covered will be stressed. *Prerequisite:* permission of the department chairman. Hours and credit as arranged. Staff.

381 THROUGH 389 SEMINAR Presentation and discussion by advanced students and staff of current developments and research in the field. *Prerequisite:* permission of the department chairman. One hour per semester.

391 THROUGH 394 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

481 THROUGH 489 DOCTORAL THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable doctoral dissertation. Credit as arranged.

DIVISION OF BIOPHYSICS

F. J. M. Sichel, Chairman

COURSES OFFERED

311, 312, 313, 314 SPECIAL PROBLEMS IN BIOPHYSICS Lectures, reports and directed readings on current problems in biophysics and medical physics. *Prerequisites:* 301-302; permission of the division chairman. Credit as arranged. Staff.

371 THROUGH 379 SEMINAR Presentation and discussion by advanced students and staff of current developments and research in the field. *Prerequisite:* permission of the division chairman. One hour per semester.

395 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable doctoral dissertation. Credit as arranged.

Current research activity in the Department of Physiology and Biophysics includes projects on the physiology and biophysics of excitation-contraction coupling and of basic contractile mechanisms in voluntary and in cardiac muscle; of auditory receptor mechanisms; of cell division; of ultrasonic effects on electrical and other properties of living cells; of endocrine relations in reproduction.

• PLANT AND SOIL SCIENCE

S. C. Wiggans, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

At least twenty semester hours in the plant and soil sciences; supporting courses in other sciences and mathematics.

MINIMUM DEGREE REQUIREMENTS

Plant and Soil Science 281, 282, 283, 284 (4 hours); 15-20 hours in Plant and Soil Science and closely related fields; thesis research (8-12 hours).
Students may specialize in either *horticultural science, agronomy* or *soil science.*

COURSES OFFERED

201 MICROMETEOROLOGY A theoretical and practical consideration of the micrometeorological factors that affect plant growth and response. The relationship of these factors to crop selection and agricultural practices. *Prerequisites:* 12 or equivalent. Three hours. Staff. Alternate years, 1966-67.

204 PLANT RESEARCH TECHNIQUES Methods of conducting research with plants. Organizing and planning of experiments. The use of field and laboratory equipment. *Prerequisites:* 12, 61, and botany 103 or equivalent. Three hours. Mr. Wiggans. Alternate years, 1965-66.

205 MINERAL NUTRITION OF PLANTS Classical work in solution culture; modern theories of ion accumulation. Collodial chemistry of roots and the rhizosphere. Measurement of ion availability in relation to uptake and growth. *Prerequisites:* 12, 61, and botany 103 or equivalent. Three hours. Mr.

Bartlett and Botany, Forestry, and Plant and Soil Science Staff. Alternate years, 1965-66.

222 ADVANCED TREE FRUIT CULTURE Theory and practice of modern commercial fruit science. Basic principles involved in nutrition and responses to cultural and management practices. *Prerequisite:* 12. Three hours. Staff. Alternate years, 1966-67.

261 SOIL FORMATION AND CLASSIFICATION A discussion of the development of soils throughout the world as influenced by soil forming factors. Detailed study of soils occurring in Vermont. Classification of soils, including the Unified System, 7th Approximation. *Prerequisite:* 61 or a total of 6 hours in ecology, geology, or geography. Two hours. Mr. Bartlett. Alternate years, 1966-67.

264 SOIL CHEMISTRY The chemistry and biology of soils as they affect plant growth. Colloidal properties of clays and organic matter in relation to soil acidity and availability of essential elements. Modern laboratory analysis of soils, fertilizers and plant tissue. *Prerequisites:* 61, Chemistry 1-2 or 11-12. Three hours. Mr. Bartlett. Alternate years, 1966-67.

266 SOIL PHYSICS The physical properties of soils. The mathematical and physical principles necessary to understand the soil-water-plant interaction and its relationship to production and management. *Prerequisites:* 61, Physics 5-6. Three hours. Mr. Benoit. Alternate years, 1967-68.

281 THROUGH 284 SEMINAR Presentation and discussion of papers on selected topics of current interest by students and staff. *Prerequisite:* senior standing. One hour. Staff.

381, 382 SPECIAL TOPICS Advanced readings and discussion of horticulture, agronomy, or soils research literature. Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Current research projects in the Department of Plant and Soil Science are concerned with the solution of both basic and applied plant and soil problems. Areas of research include winter hardiness of plants, plant virus identification and control, chemical and environmental control of plant growth, soil-water-plant interrelationships, soil chemistry, soil fertility, plant establishment and management, fertilizer and crop variety testing, drainage of agricultural lands, and cultural and environmental interrelationships as they affect plant growth.

Undergraduate courses:

1 Home and Garden Horticulture
12 Introduction to Plant Science
61 Introduction to Soil Science
101 Natural Resource Conservation
104 Pest Control
122 Small Fruit Crops

123 Vegetable Crops
125 Ornamental Horticulture
128 Plant Propagation
141 Forage Crops
144 Field Crops
145 Turfgrasses
161 Soil Fertility and Management
197, 198 Senior Research

• POLITICAL SCIENCE

A. E. Nuquist, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Twelve hours of Political Science at the junior-senior level; supporting courses in other social sciences; satisfactory scores on the Graduate Record examination.

MINIMUM DEGREE REQUIREMENTS

12 hours of the following courses (unless taken as an undergraduate): 211, 212, 221, 222, 281, 282; additional courses in Political Science; approved courses in related fields (6 hours); thesis research (6-12 hours).

COURSES OFFERED

Admission to the following courses for graduate credit requires the approval of the Department.

211, 212 POLITICAL THEORY Development of political theory; recent political theory. Three hours. Mr. Staron.

216 AMERICAN POLITICAL THOUGHT The development of American political thought from the colonial period to recent times. Three hours. Mr. Simon.

221, 222 CONSTITUTIONAL LAW First semester: historical and analytic study of judicial review, federalism, the taxing power, the suffrage. Second semester; historical and analytic study of the war power, the executive power, due process of law, citizenship, Bill of Rights, and equal protection of the laws. Three hours. Mr. Gould.

226 ADMINISTRATIVE LAW A study of judicial decisions affecting the actions of public officials as they relate to the functions and policies of government. *Prerequisite:* 241 or 263. Three hours. Mr. Wilson.

227 INTERNATIONAL LAW Principles and applications of public international law. Three hours. Alternate years, 1966-67. Mr. Little or Mr. Durham.

231 THE LEGISLATIVE PROCESS Congressional and parliamentary organization and procedures. Three hours. Alternate years, 1965-66. Mr. Haugen.

232 LAWMAKING AND PUBLIC POLICY Influence of the executive and problems of congressional and parliamentary control. Three hours. Alternate years, 1965-66. Mr. Haugen.

241 INTRODUCTION TO PUBLIC ADMINISTRATION The role of the executive in fulfilment of public policy; theories of administrative organization and function. Three hours. Mr. Wilson.

242 ADMINISTRATIVE PROCEDURES Factors governing administrative action in selected fields. *Prerequisite:* 241 or 263. Three hours. Mr. Wilson.

251, 252 AMERICAN FOREIGN POLICY First semester: constitutional principles, institutional factors, and historic traditions in the formation of foreign policy. Second semester: contemporary policies toward specified countries. Three hours. Mr. Hilberg.

253-254 WORLD POLITICS Analysis of the foreign policies of countries other than the United States; selected problems in Europe, Latin America and the Pacific Area. Three hours. Mr. Keene.

256 INTERNATIONAL ADMINISTRATION Theory and practice in international agencies. *Prerequisite:* 227. Three hours. Alternate years, 1966-67. Mr. Little or Mr. Durham.

257 POLITICAL GEOGRAPHY This course is identical with Geography 257, see p. 69.

258 PROBLEMS OF COMMUNISM This course is identical with Economics 258, see p. 52.

263 STATE GOVERNMENT Processes of basic policy formulation and popular control in the fifty states, the nationwide effort to improve governmental systems and the theoretical bases of the movements, and trends in the treatment of governmental problems. Three hours. Mr. Haugen.

264 STATE ADMINISTRATION The effect of expansion in state activity, problems in policy determination, the responsibility and accountability of officers and agencies, the organization and maintenance of central services and controls, and the impact of study and investigation by legislative committees, interim commissions, councils, and citizens groups. *Prerequisite:* 241 or 263. Three hours. Mr. Haugen.

265, 266 INTERGOVERNMENTAL RELATIONS Problems of the federal system; cooperative administration of selected public functions. Three hours. Alternate years, 1966-67. Mr. Haugen.

271, 272 POLITICAL PARTIES AND PRESSURE GROUPS Political parties; citizen participation and interest groups. Three hours. Mr. Best.

277 THE GOVERNMENT OF THE USSR This course is identical with History 277, see p. 76.

278 FOREIGN POLICY OF THE USSR This course is identical with History 278, see p. 76.

279 COMPARATIVE PUBLIC ADMINISTRATION Universal applicability of basic administrative concepts evident in the administrative systems and environments in selected countries in Europe, the Commonwealth, and elsewhere; problems and developments in established and in emergent countries. *Prerequisite:* 241. Three hours. Mr. Wilson.

281, 282 SEMINAR Seminar in popular government for senior and graduate students. *Prerequisite:* permission of the department. Three hours. Staff.

291, 292, 293, 294 READING AND RESEARCH Three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged. Staff.

Research interests of the Department of Political Science and the various library resources available enable graduate students to undertake research in state and local government; public law; United States public policy formation and administration; foreign policy making; foreign governments; and international relations.

Undergraduate courses:

11, 12 Introduction to Political Science
21, 22 American Government
51, 52 International Relations
61, 62 Local Government
171 Government of Great Britain
172 Governments of Continental Europe
174 Governments of the British Commonwealth
175 Governments of the Far East
176 Governments of Latin America

• POULTRY SCIENCE

G. A. Donovan, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An acceptable undergraduate major in Poultry Science, in a related field, or in Chemistry.

MINIMUM DEGREE REQUIREMENTS

281, 282 (2 hours); additional courses in Poultry Science and related fields; thesis research (6-15 hours).

COURSES OFFERED

281, 282, 283, 284 SEMINAR A review of recent developments and current literature in Poultry Science and related fields. *Prerequisite:* permission of the department. One hour. Staff.

294 HISTORY OF NUTRITION This course is identical with Home Economics 294, see p. 79.

307 ADVANCED CONCEPTS IN NUTRITION Study of chemistry and physiology of digestion, absorption, and metabolism of nutrients. Methods of estimating and meeting dietary requirements for maintenance, growth, and reproduction of several species. Genetic and nutritional interrelationships. Basic study of growth per se. *Prerequisites:* one of the following: Animal and Dairy Science 206; Home Economics 243, or a 200 level course in Biochemistry. Three hours. Mr. Donovan and Miss Morse. Alternate years, 1965-66.

308 EXPERIMENTAL TECHNIQUES IN NUTRITION This course is identical with Animal and Dairy Science 308, see p. 39.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

Undergraduate courses:

1 General Poultry Science
58 Introductory Avian Biology
102 Incubation and Brooding
103 Processing and Packaging Poultry Products
151 Poultry Breeding

• PSYCHOLOGY

D. G. Forgays, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Undergraduate courses in Statistics, Systematic Psychology and Experimental Psychology; satisfactory scores on the Graduate Record Examination and the Miller Analogies Test.

MINIMUM DEGREE REQUIREMENTS FOR MASTER OF ARTS DEGREE

Twenty-four hours of Psychology courses and seminars, including Psychology 303, 304, 305, 306; thesis research for 6 credits. The requirement of the specific courses (303, 304, 305, 306) may be exempted by examination. Satisfactory performance on the departmental master's comprehensive examination.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory completion of minimum degree requirements for Master of Arts degree, except for thesis; satisfactory performance on the departmental doctoral

preliminary examination; completion of one of the languages of the language requirement.

MINIMUM DEGREE REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

In addition to the 30 credit hours required for the master's degree, 45 credit hours mainly in courses numbered in the 300 or 400 sequences of the psychology curriculum including thesis, or acceptable courses at the 200 or 300 level from other curricula.

COURSES OFFERED

222 PHYSIOLOGICAL PSYCHOLOGY Relationships between psychological processes and the functions of the nervous system and endocrine glands. *Prerequisite:* 110, 123. Three hours. Mr. Patterson.

225-226 PSYCHOLOGICAL TESTS A survey of important clinical tests of ability and personality; training in the administration of individual intelligence tests. *Prerequisite:* 110, 123. Three hours. Mr. Ansbacher.

230 LEARNING Study of the basic laws of the learning process as revealed by controlled experiments; emphasis will be placed upon specific phenomena and the variables which govern them. Students may undertake original experiments. *Prerequisite:* 110, 123. Three hours. Mr. Slamecka.

231 PERCEPTION An experimental and theoretical study of the perceptual processes. The traditional problems of space, form and movement perception will be included, followed by consideration of the role of social and motivational factors. *Prerequisite:* 110, 123. Three hours. Mr. Patterson.

232 EXPERIMENTAL SOCIAL PSYCHOLOGY A laboratory course in experimental methods and techniques typically used in social psychological research. Experiments will be designed, conducted, and evaluated in such areas as attitude formation and change, conformity, motivation, prejudice, rumor, social perception, and suggestion. Techniques used in attitude measurement and public opinion surveys will also be examined and applied. *Prerequisite:* 110, 123. Three hours. Mr. Perrine.

234 MOTIVATION AND EMOTION The nature and development of motives, emotions and their relation to other psychological processes. *Prerequisite:* 110, 123. Three hours. Mr. Chaplin.

281-282 SENIOR SEMINAR Review and discussion of current psychological research. Required of seniors concentrating in Psychology. *Prerequisites:* 110, 123. One hour. Staff.

The prerequisite for all of the courses listed below is acceptance to the graduate psychology program which involves the satisfactory completion of undergraduate courses in experimental psychology, systematic psychology, and statistics. In special cases, these prerequisites may be waived by permission of the instructor. Additionally, acceptance to Master's degree candidacy is a prere-

quisite to Psychology 391 through 399 and acceptance to Doctor's degree candidacy is a prerequisite to Psychology 491 through 499.

303-304 ADVANCED GENERAL PSYCHOLOGY This course serves as an overview of the field. It will emphasize empirical findings from the frontiers of the field and relate them to the body of psychology as it is developing today. Experiments will be undertaken by each student. Three hours. Mr. Chaplin.

305-306 ADVANCED STATISTICAL METHODS Study of statistical methods as aids for understanding and evaluating psychological data. Critical study of such topics as sampling theory, statistical estimation, simple and complex analysis of variance, non-parametric methods, simple and complex correlative techniques. Three hours. Mr. Ghei.

311 SEMINAR IN LEARNING THEORY An examination of selected contemporary theoretical approaches to learning and a study of recent research contributions to such problem areas as social learning, emotional learning, the physiology of learning, etc. Three hours. Mr. Mayhew.

312 SEMINAR IN VERBAL LEARNING Selected problems in verbal learning and memory will be studied by means of a detailed critical examination of the relevant literature. Current topics such as the serial position effect, remote associations, short-term memory, the stimulus in serial learning, and pre-experimental associations will be examined. Three hours. Mr. Slamecka.

314 COMPARATIVE PSYCHOLOGY OF BEHAVIORAL DEVELOPMENT An examination of the general principles underlying the development of behavior from prenatal to adult responding. Focus will be on the pertinent research literature, particularly as it concerns the influence of various kinds of experience in early life upon later functioning. Three hours. Mr. Forgays.

321 SENSORY PROCESSES A study of the structure and function of the sense organs. Emphasis will be on research technique and methodology. Three hours. Mr. Patterson.

322 CENTRAL PROCESSES Basic neurophysiological psychology with emphasis on the control of behavior by the brain. Neuronal and synaptic transmission, chemical modulators of brain activity, basic organization of the nervous system. *Prerequisite:* 321. Three hours. Mr. Patterson.

326 INTRODUCTION TO CLINICAL PSYCHOLOGY Initially this course will be a study of the basic principles of interviewing, testing, assessment from life situations, and report writing. Later there will be an examination of the most common approaches to psychotherapy, such as the client-centered, habit change, cognitive change, emotional change, interpersonal relations, and group therapy approaches. Three hours. Mr. Ansbacher.

327 SEMINAR IN JUDGMENTAL PHENOMENA Survey of the basic methodological and theoretical problems involved in the process of making human judgments. Three hours. Mr. Perrine.

328 SEMINAR IN SOCIAL PERCEPTION Examination of the process through which impressions and judgments of man and other social objects are reached. Three hours. Mr. Perrine.

330 SEMINAR IN OPERANT CONDITIONING A review of current developments in this area of research. Negative and positive reinforcement; discrimination training and generalization; applications of operant techniques. Three hours. Mr. Leitenberg.

381, 382, 383, 384 ADVANCED READINGS Readings, with conferences, to provide graduate students with background and specialized knowledge relating to an area in which an appropriate course is not offered. One to three hours. Staff.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of a staff member. Credit as arranged. Staff.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Credit as arranged. Staff.

Undergraduate courses:

1 General
110 Experimental
123 Systematic

• SOCIOLOGY AND ANTHROPOLOGY

P. Oren, Jr., Chairman

No Master's degree program offered

COURSES OFFERED

205 SMALL-GROUP DYNAMICS Analysis of processes and problems of interaction at the level of the social microcosm; implications for the understanding of large-scale social organization. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Oren.

210 POPULATION ANALYSIS The demographic and ecological analysis of societies with particular reference to contemporary world problems. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Maher.

212 THE COMMUNITY Analysis of the structure and function of communities as social systems with special emphasis on American communities. Attention will be given to ecology, social class and power structure, and social change within the community context. Procedures for sociological study of communities will be described. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Lewis.

214 PUBLIC OPINION Analysis of attitude formation and the basis in social structure of differing tendencies toward collective behavior; implications

for the analysis of political institutions. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Maher.

221 CULTURE AND PERSONALITY Relationship of socialization to the socio-cultural milieu; the cross-cultural comparison of personality development; delineation of modal personality types; variations in child-rearing situations. *Prerequisites:* 9 hours of Sociology, including 101; Psychology 1. Three hours. Mr. Oren.

225 CULTURAL CHANGE The data and theories of socio-cultural dynamics: innovation, diffusion, acculturation, revitalization; theories of cultural evolution, culture circles, and the American historical school. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Haviland.

228 SOCIAL ORGANIZATION Evaluation of the comparative method in anthropology; its use in the formulation of generalizations concerning the nature of society. *Prerequisite:* 9 hours of Sociology, including 101. Three hours. Mr. Johnson.

251 SOCIAL RESEARCH METHODS The logic and techniques of sociological inquiry. *Prerequisite:* 12 hours of Sociology, including 101; permission of the department. Three hours. Mr. Kennedy.

282 SEMINAR Topical seminar centering on some problem of central concern to the field; stresses reading in current sociological literature and professional journals. *Prerequisites:* 12 hours of Sociology; permission of the department. Three hours. Staff.

Research activities in the Department of Sociology and Anthropology include studies of community and family structure, both American and cross-cultural, the impact of socio-cultural change on the division of labor in American society, Vermont elections, adolescent sub-cultures, and the development of early Mayan civilization.

Undergraduate courses:

21 The Cultures of Man
41 Social Problems
51 The Family
54 Minority Groups
61 Peoples of the Americas
62 Peoples of Africa
63 Peoples of Asia and Oceania
65 Peoples of China and Japan
71 Sociology of Health and Medicine
83 Applied Anthropology
101 Sociological Analysis

• SPANISH

M. *D. Daggett, Chairman* [Romance Languages]

No Master's degree program currently offered.

COURSES OFFERED

213, 214 SPANISH LITERATURE: GOLDEN AGE The picaresque novel, the drama and poetry of the 16th and 17th centuries, with emphasis on Lope

de Vega, Calderón, Quevedo, Tirso de Molina. *Prerequisites:* any Spanish literature course numbered 100 or above, 213 for 214. Alternate years, 1966-67. Three hours. Mr. Weiger.

215-216 SPANISH LITERATURE: CERVANTES Don Quijote, the Novelas Ejemplares, and the theater of Cervantes. *Prerequisite:* any Spanish literature course numbered 100 or above. Alternate years, 1965-66. Three hours. Mr. Weiger.

223-224 ADVANCED COMPOSITION AND CONVERSATION Translation into Spanish of difficult English prose, free composition and discussion of questions of style. Practice in advanced conversation. Required of those who wish to be recommended to teach Spanish. *Prerequisite:* 121-122. Three hours. Mr. Ugalde.

Research activities in Spanish are confined to the sixteenth, seventeenth and twentieth centuries.

Undergraduate courses:

1-2 Elementary Spanish
11-12 Intermediate Spanish
101 Spanish Literature: 19th Century
102 Spanish Literature: 20th Century
105 Readings in Spanish American Literature: Colonial Period
106 Readings in Spanish American Literature: Contemporary Period
121-122 Conversation and Composition

• SPEECH

R. B. Huber, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE IN SPEECH PATHOLOGY

An undergraduate major in Speech with eighteen hours in speech pathology and psychology, or a major in Psychology with a minor in Speech, or a major in Education with twenty-four hours in Speech and Psychology; nine hours in speech pathology to be included within the above major.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours of graduate level courses including 18 hours in speech pathology and audiology, 6 hours in speech pathology or a related field; thesis research (6 hours); demonstration of proficiency in oral communication; written examination; oral examination. Undergraduate plus graduate courses must include nine hours of audiology.

COURSES OFFERED

201 PHONETICS Analysis of English speech sounds used in the International Phonetic Alphabet. Application to standards of English pronunciation in the United States and to foreign dialects. *Prerequisites:* Junior standing and 9 hours of Speech; or English 25, 26 or 27, 28; or a foreign language through the intermediate level. Three hours. Miss Luse.

221 GENERAL SEMANTICS A study of the theory of communication both verbal and non-verbal, with an emphasis upon the factors of inter- and intra-personal communication breakdowns. *Prerequisite:* 6 hours of Speech. Three hours. Mr. Lewis.

271 SPEECH PATHOLOGY I The etiology, symptoms and principles of habilitation for voice disorders, cleft palate; historical aspects of stuttering; problems of foreign accent. *Prerequisites:* 12 hours of Speech and Psychology including Speech 74. Three hours. Miss Luse.

272 SPEECH PATHOLOGY II The etiology, symptoms and treatment of retardation of speech, including congenital aphasia, aphasia in adults, and cerebral palsy. *Prerequisites:* 12 hours of Speech and Psychology including Speech 74. Three hours. Mr. B. Carr.

273 PRINCIPLES OF AUDIOLOGY Anatomy and physiology of the ear; history of audiometry; diagnostic hearing tests. *Prerequisites:* 12 hours of Speech and Psychology, including Speech 74. Three hours. Mrs. Falck.

274 SPEECH READING AND AUDITORY TRAINING Principles of teaching speech reading and auditory training to the hard of hearing. *Prerequisite:* 273. Three hours. Mr. B. Carr.

275, 276 CLINICAL STUDY IN SPEECH DIAGNOSIS AND THERAPY Observation and practice in diagnosis and therapy of speech disorders. *Prerequisites:* 12 hours of Speech and Psychology, including Speech 271 or 272. Credit as arranged. Mr. Kallstrom.

281 VOICE SCIENCE The anatomical, physiological and physical factors of speech. *Prerequisite:* 12 hours of Speech and Psychology. Three hours. Miss Luse.

283 CLINICAL AUDIOLOGY Advanced audiological testing and clinical procedures. *Prerequisite:* 273. Three hours. Mrs. Falck.

381, 382 ADVANCED READINGS Readings, with conferences, intended to contribute to the programs of graduate students in phases of speech for which formal courses are not available. *Prerequisites:* 271, 272. Credit as arranged, up to 3 hours each semester. Miss Luse and Mr. B. Carr.

385 SEMINAR IN VOICE Study of the research in voice production and speech. Application to pathological and non-pathological problems. *Prerequisite:* 271, 272. Three hours. Miss Luse.

386 SEMINAR IN CEREBRAL PALSY Study of the pathology, etiology, methods in diagnosis, and the rehabilitative procedures used with the various types of cerebral palsy. *Prerequisite:* 271, 272. Three hours. Miss Luse.

387 SEMINAR IN LANGUAGE DISORDERS Study of the different types of language disorders, examination procedures, and methods of rehabilitation. *Prerequisite:* 271, 272. Three hours. Mr. B. Carr.

388 SEMINAR IN STUTTERING Study of the research in stuttering relative to etiology and rehabilitation. *Prerequisite:* 271, 272. Three hours. Mr. B. Carr.

396 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

294 SEMINAR FOR PROSPECTIVE TEACHERS OF SPEECH A study of the resources, procedures and methods utilized in teaching the different areas of speech at the various instructional levels. *Prerequisite:* 15 hours including Speech 1 and 11. Three hours. Mr. London.

Current interests and research in the Department of Speech include the development of the Summer Shakespeare Festival; studies of the dialects of the people of Vermont; studies concerning cancer of the larynx and the rehabilitation of such individuals using esophageal speech; a study using x-rays to determine the effectiveness of rehabilitating cleft palate speech; and studies concerning the establishment of educational television and networks along with the establishment of educational FM radio broadcasting.

Other courses:

1 Basic Speech
3 Parliamentary Procedure
11 Public Speaking
12 Argumentation
14 Group Discussion
31 Oral Interpretation of Literature
41 Acting
61 Introduction to Radio and Television Broadcasting
74 Introduction to Speech Correction
111 Persuasion
116 Speech Composition
141 Advanced Acting
142 Play Directing
145, 146 Development of the Western Theatre
151 Stagecraft and Lighting
161 Elements of Broadcasting
162 Writing for Radio and Television
163 Broadcast Materials
254 Scene Design

• ZOOLOGY

R. W. Glade, Chairman

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in zoology or its equivalent.

MINIMUM DEGREE REQUIREMENTS

Zoology Seminar each semester; 15-22 additional hours in zoology and related fields; thesis research (8-15 hours).

The department also offers a program leading to the degree of Master of Arts in Teaching: Cf. p. 20.

PREREQUISITES FOR ACCEPTANCE TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory completion of: an academic year of graduate study in the University of Vermont; a year of Mathematics and one of Physics (college courses of appropriate level for students majoring in science); Organic Chemistry; at least one year of Zoology. Students whose programs are to include Physical Chemistry should have had, or should take, mathematics through Mathematics 21 or its equivalent. Satisfactory showing in an oral qualifying examination. Acceptability to the faculty member with whom the candidate wishes to do his thesis research.

MINIMUM DEGREE REQUIREMENTS

Of the 75 credit hours required for the degree, at least 40 hours must be earned in courses suitable for graduate credit, the selection of courses to be designated for each student by his Studies Committee. Of these courses a minimum of 13 credits must be in courses other than Zoology. At least 20, but not more than 40, credits must be earned in thesis research. Attendance at seminar required. Language requirement: reading knowledge of two appropriate foreign languages. Each candidate must demonstrate his ability as a teacher by participation in the teaching of at least one advanced undergraduate course.

COURSES OFFERED

203 POPULATION ECOLOGY Dynamics, composition, and density regulation of animal population. *Prerequisite:* 104. Four hours. Mr. Potash. Alternate years, 1967-68.

207 VERTEBRATES Classification, ecology, behavior, evolution, and distribution of vertebrates other than birds. *Prerequisite:* 42, either 2 or 21, and a course in zoology numbered above 100. Four hours. Mr. Bell.

216 HUMAN GENETICS Principles of human inheritance; population genetics; interaction of heredity and environment; application of principles of heredity to human problems. *Prerequisite:* 115 or Botany 255. Three hours. Mr. Moody.

222 EXPERIMENTAL EMBRYOLOGY Theoretical approach to major problems of devlopment based on modern research in embryology, genetics, physiology, bacteriology, and related fields. *Prerequisite:* 111 and consent of the instructor. Four hours. Mr. Glade. Alternate years, 1965-66.

231 CELL PHYSIOLOGY Study of cell function, with emphasis upon experimental techniques used to elucidate chemical and physical mechanisms within living cells. *Prerequisite:* a course in zoology numbered above 100; Chemistry 131-132 and consent of the instructor. Four hours. Mr. Rothstein.

236 FRESH-WATER BIOLOGY Organisms of lakes, ponds and streams; their adaptations to varying physical, chemical and biotic conditions. *Prerequisite:* A course in zoology numbered above 100; inorganic chemistry. Four hours. Mr. Henson.

255 COMPARATIVE ANIMAL PHYSIOLOGY General principles of function, mainly in invertebrate animals. *Prerequisite:* 104, 150 or 236; Chemistry 131-132; and consent of the instructor. Four hours. Mr. Rothstein.

267 GENETICS OF DEVELOPMENT Problems of differentiation and morphogenesis approached from the viewpoint of gene action and biosynthesis; influence of hereditary material during ontogeny. *Prerequisite:* 111, 115, and consent of the instructor. Four hours. Mr. Bromley. Alternate years, 1966-67.

270 MODERN EVOLUTIONARY THEORY Contributions of modern research in genetics, systematics, distribution, experimental embryology, serology, and related fields to problems of the means and methods of evolutionary change. *Prerequisite:* a course in evolution and one in heredity or genetics. Three hours. Mr. Moody.

271 ADVANCED LIMNOLOGY Analyses of current limnological concepts and problems. *Prerequisite:* 236. Four hours. Mr. Henson.

281 THROUGH 289 SEMINAR Review and discussion of current zoological research. Required of graduate students and seniors concentrating in zoology; open to others by special permission only. Required of all departmental graduate students. No course credit. Staff.

381 THROUGH 386 ADVANCED READINGS Readings, with conferences, or small seminar groups, intended to contribute to the programs of graduate students in phases of zoology for which formal courses are not available. *Prerequisite:* an undergraduate major in zoology. Credit as arranged.

391 THROUGH 399 MASTER'S THESIS RESEARCH Investigation of a research topic under the direction of an assigned staff member, culminating in an acceptable thesis. Credit as arranged.

491 THROUGH 499 DOCTORAL THESIS RESEARCH Original research under the direction of an assigned staff member, culminating in an acceptable doctoral dissertation. Credit as arranged.

Current research interests in the Department of Zoology include classification of the Carabidae; experimental embryology; physiology of triploid amphibians; control of morphogenesis in amphibian limb regeneration; crustacean anatomy and physiology; aquatic ecology; cell physiology; reproductive physiology and physiological ecology of vertebrates; statistical morphology.

Undergraduate courses:

1 Introduction to Zoology
2 Principles of Evolution
5-6 Mammalian Anatomy and Physiology
21 Organic Evolution
41, 42 Comparative Vertebrate Anatomy
52 Physiology
104 Animal Ecology
108 General Entomology
109 Field Zoology
111 Embryology
112 Comparative Histology
115 Heredity
150 Invertebrate Zoology

• INDEX

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