GRADUATE CATALOGUE

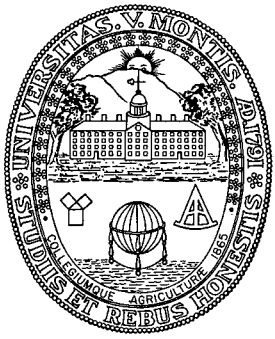
UNIVERSITY OF VERMONT

1983-1984

GRADUATE COLLEGE

UNIVERSITY OF VERMONT

Burlington, Vermont



CATALOGUE and ANNOUNCEMENTS

1983-84

Correspondence:

Please address all inquiries and correspondence concerning applications and admission to the Graduate College Admissions Office, University of Vermont, Burlington, Vermont 05405; telephone (802) 656-2699. For other matters concerning the Dean, telephone (802) 656-3160.

Please address requests for transcripts from the University of Vermont to the Registrar, University of Vermont, Burlington, Vermont 05405.

Please address requests for Summer Session and Evening Division information to the Office of Continuing Education, University of Vermont, Burlington, Vermont 05405.

Application Deadlines:

March 1 — For applications requesting financial aid.
April 1 — For applications to most departments.

Exceptions:

February 1 — Psychology
March 1 — Historic Preservation and Doctorate in Education (Ed.D)

Details on the above exceptions are given on page 36. Applicants should also consult individual program descriptions.

The University of Vermont fully supports and complies with Title VI of the Civil Rights Act of 1964 and does not discriminate in any way in any of its policies on the basis of race, color, religion, sex or national origin.

The University has embarked on a program to remove architectural barriers to make facilities accessible to and usable by the handicapped. Questions may be referred to the Office of Architectural Barrier Control. The University of Vermont does not discriminate on the basis of handicap in the admission or funding of graduate students.

Please be advised that information provided herein is subject to change without notice in accordance with established University procedures. Circumstances occasionally require instructor changes and changes in the timing of specific course offerings.

Produced by the Office of Academic Affairs in cooperation with the Graduate College Dean's Office. Production Manager: Joann Mannion. Typographer: Nancy Hankey Holzapfel. Cover: Joann Mannion.

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"Burlington, Vt. 1858 from the Lake," drawn by Henry P. Moore, a New Hampshire artist, and lithographed by Endicott & Co., New York, in 1858. During the late 1850's Moore published similar views of a number of Vermont towns, including Bradford, Ludlow, and St. Johnsbury.

This antebellum view shows Burlington just 10 years before it mushroomed into the third largest lumber port in the northeastern United States. The empty fields would soon begin to fill up with housing for industrial laborers. At this time, the mercantile village focused its retail and wholesale business at the waterfront.

The two sidewheelers in the foreground are the passenger boats BOSTON and AMERICA. Just beyond the latter can be seen the Old Salt Dock (now called Perkins Pier). Follett & Bradley's Old Stone Store is at the landward end of this dock. This was the largest wholesale house in Vermont at the time. At the far right a train can be seen passing between the lake and the Rutland Railroad terminal. In the middle in the harbor is another sidewheeler towing four barges north towards Canada.

Identifiable buildings include the Unitarian Church tower (far left) and the Pioneer Mechanic's Shop on the waterfront, Burlington's first industrial structure. The gable of the Follett house appears almost dead center of the picture, and just to the right of this, two flag poles mark City Hall Park, one pole each for Democrats and Republicans. The domed town hall can be seen with the towered court house just to the north of it. At the top of the hill stands the University's second Old Mill — then housing the entire University. As the picture shows, it was one of the largest buildings in town at the time, and its dome was a landmark which could be seen a great distance out onto the lake.

Wilbur Collection, Bailey/Howe Library

Academic Calendar

FALL SEMESTER 1983

August 29	Registration
August 30	Classes begin
September 5	Labor Day Holiday
October 14	Fall Recess
November 16-18	Preregistration
November 23-27	Thanksgiving Recess/Holiday
December 9	Classes end
December 13	Exams begin
December 17	Exams end

SPRING SEMESTER 1984

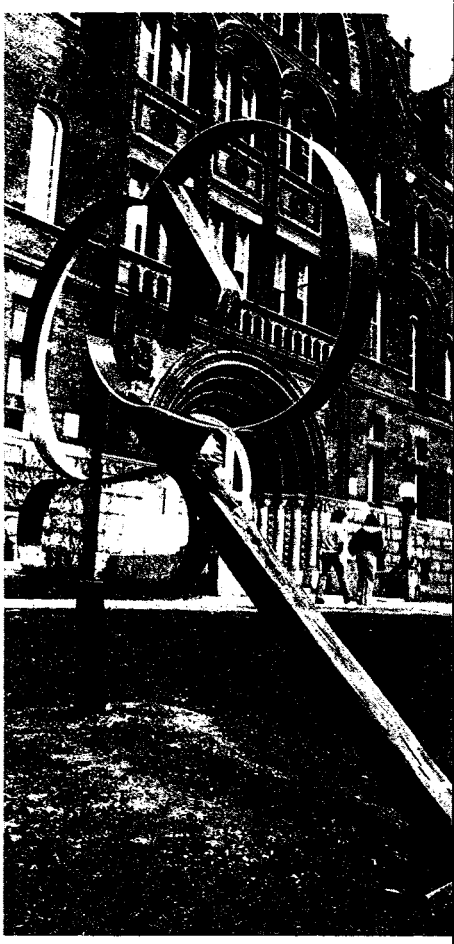
January 16	Registration
January 17	Classes begin
February 20	Washington's Birthday Holiday
March 6	Town Meeting Day Recess
March 19-23	Spring Recess
April 18-20	Preregistration
April 23	Honors Day
May 2	Classes end
May 5	Exams begin
May 10	Exams end
May 19	Commencement

FALL SEMESTER 1984

August 27	Registration
August 28	Classes begin
September 3	Labor Day Holiday
October 12	Fall Recess
November 14-17	Preregistration
November 21-25	Thanksgiving Recess/Holiday
December 11	Classes end
December 13	Exams begin
December 18	Exams end

SPRING SEMESTER 1985

January 15	Registration
January 16	Classes begin
February 18	Washington's Birthday/Holiday
March 5	Town Meeting Day Recess
March 18-22	Spring Recess
April 17-19	Preregistration
April 22	Honors Day
May 3	Classes end
May 7	Exams begin
May 11	Exams end
May 18	Commencement



The University of Vermont

THE UNIVERSITY OF VERMONT AND BURLINGTON COMMUNITY

The University of Vermont 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 of substantial private support, University development has been identified closely 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 bylaws 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 to go on public record as supporting freedom of religion upon its campus.

The University of Vermont consists of the Colleges of Agriculture, Arts and Sciences, Engineering and Mathematics, Education and Social Services, Medicine, and the Graduate College; the Schools of Allied Health Sciences, Business Administration, Natural Resources, and Nursing; and Continuing Education.

The present physical plant is valued at more than $55,000,000, a major share made possible through the interest and support of alumni and private philanthropy.

The University and the people of the Burlington area have long enjoyed cordial relations dating from 1800 when Burlington citizens voluntarily subscribed the necessary funds to provide Vermont's first institution of higher learning with its first building.

With a population of about 38,000, Burlington is Vermont's largest city. The greater Burlington area of approximately 125,000 inhabitants is divided between pleasant suburbs and picturesque farms and woodland. Burlington enjoys magnificent views of Lake Champlain and the Adirondack Mountains to the west and Vermont's Green Mountains to the east. Easily available outdoor activities include swimming, boating, hiking, climbing, and skiing.

Some 200 miles northwest of Boston, 300 miles north of New York City, and about 100 miles south of Montreal, Burlington is served by U.S. Air, Air Florida, Air New England, Air North, People Express, United Airlines, Vermont Transit and Greyhound Bus Lines, and Amtrak, and is contiguous to Vermont's interstate highway system.

THE GRADUATE COLLEGE

The Graduate College of the University of Vermont is responsible for all advanced degree programs except the program leading to the degree of Doctor of Medicine. Accordingly, the College serves all persons seeking advanced and comprehensive knowledge of the scholarship and research in a particular field of study beyond the baccalaureate degree.

Although the Graduate College was established formally in 1952 under a full-time Dean, the University of Vermont recognized early the value of graduate education and awarded its first master's degree in 1807. Today, the Graduate College offers 56 different master's programs of study and

sixteen doctoral programs. During the 1982-83 academic year, 311 master's and 23 Doctor of Philosophy degrees were awarded.

The Graduate College is served by an Executive Committee which is composed of 10 faculty and a graduate student member. The Executive Committee works closely with the Dean of the Graduate College to insure comprehensive and outstanding programs of study. Currently, the College enrolls approximately 1,000 students, with about 250 of these pursuing the doctorate.

A variety of scholarships, fellowships, assistantships, and special loan programs are available in modest number to students with solid and sustained records of academic performance. The combination of sound library holdings, laboratories, and computer facilities, along with the engaging size of the university, affords a unique opportunity to pursue high quality graduate programs in a challenging yet personable environment.

University Scholar, Richmond J. Bartlett

THE UNIVERSITY SCHOLARS

The University Scholars program was established by the Graduate College to recognize the outstanding contributions of selected Graduate Faculty to research and scholarship in their areas of specialization as well as their sustained contributions to graduate education at the University

of Vermont. Nominations for a University Scholar Award are made by members of the faculty and are reviewed by the appropriate Study Sections of the University Committee on Research and Scholarship and the Executive Committee of the Graduate College. The University Scholars for the 1983-84 academic year are Professors Richmond J. Bartlett (Plant and Soil Science), James F. Clapp, III (Obstetrics and Gynecology), William E. Geiger, Jr. (Chemistry), and Philip S. Kitcher (Philosophy). Other recently selected University Scholars include:

Bilogical Sciences
Richmond J. Bartlett, Plant and Soil Science (1983-84)
Alexander H. Duthie, Animal Sciences (1981-82)
George M. Happ, Zoology (1982-83)
Robert C. Ullrich, Botany (1980-81)

Medical Sciences
James F. Clapp, III, Obstetrics and Gynecology (1983-84)
Thomas J. Moehring, Medical Microbiology (1982-83)
Brooke T. Mossman, Pathology (1981-82)

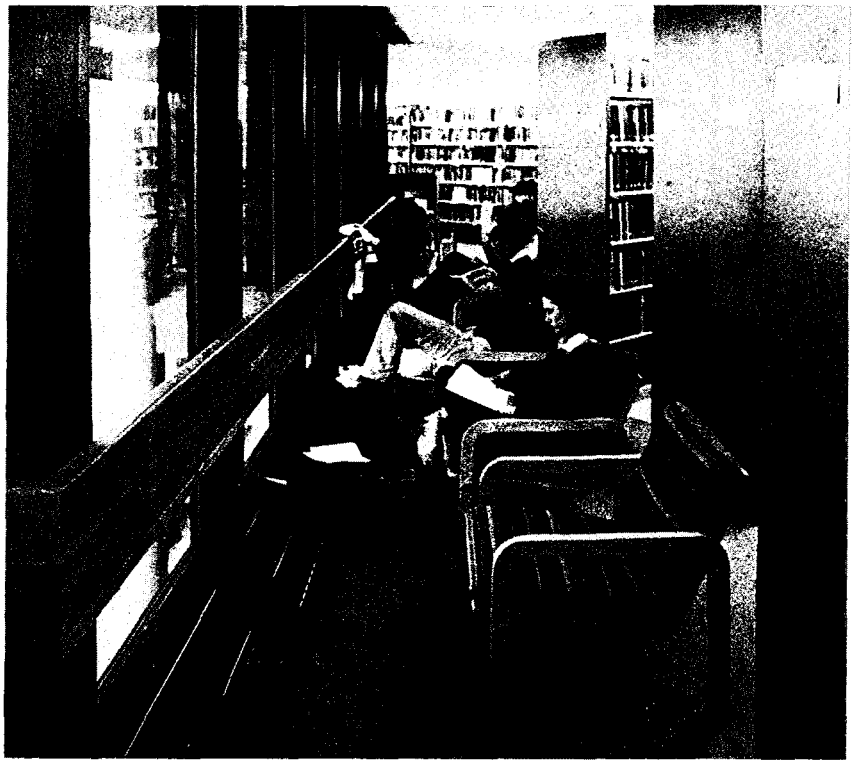
Physical Sciences
Christopher W. Allen, Chemistry (1982-83)
David B. Brown, Chemistry (1981-82)
William E. Geiger, Jr., Chemistry (1983-84)
Stanley Rush, Electrical Engineering and Computer Sciences (1980-81)

Social Sciences and Humanities
Robert V. Daniels, History (1981-82)
Philip S. Kitcher, Philosophy (1983-84)
Harold Leitenberg, Psychology (1982-83)
Wolfgang Mieder, German and Russian (1980-81)

RESOURCES FOR RESEARCH AND SCHOLARSHIP, AND CULTURAL ACTIVITIES

The University Libraries. The main Library (Bailey-Howe) was dedicated in 1961, and the physical facilities were doubled in size in 1979. The Bailey-Howe Library holds the largest book collection in Vermont, and acquires regularly major periodicals, scholarly journals, and indexing and abstracting services. The University collections also include books in medicine and health-related sciences, and a strong collection in medical periodical literature maintained in the Dana Medical Library of the Division of Health Sciences.

The Bailey-Howe Library is a depository for United States and Canadian government publications, and acquires newspapers, pamphlets, maps, and materials in microfilm. The Special Collections Department



includes books and manuscripts from the library of George P. Marsh, and a significant Masefield poetry collection; its Wilbur Collection is rich in books and manuscripts of those associated with the State, including Ira Allen, Henry Stevens, Dorothy Canfield, Vermont Governors, and members of the State Congressional delegation.

The Physics and Chemistry Library is located in the Clinton D. Cook Physical Sciences building.

The University Archives in the Waterman Building contain the permanent official records of the University.

The Academic Computing Center. The Academic Computing Center provides computing facilities for the campus community. The Center (DEC System 2060 and Harris) services the computation needs of the varied research projects on campus; its facilities are also used as an integral part of many graduate and undergraduate courses.

The staff of the Computing Center is available to anyone who requires assistance with the use of the terminals or programming. A large up-to-date program library is maintained by the Center for use by University personnel.

The Robert Hull Fleming Museum. The Museum, which is currently undergoing new construction and renovation, houses a notable University collection of Western and non-Western art, and is a center for research and museological studies as well as a place for aesthetic exploration. The Reed Collection of Plains Indian Art and the Schnackenberg Collection of 19th and 20th-century American Art, for example, are outstanding and of particular interest to students of American art and history. Exhibits are frequently rotated to serve class and seminar needs. Two galleries are given to changing exhibitions on special topics. These are frequently augmented by lectures, gallery talks, and films. Besides facilities to support the scholarly use of the collections, the Museum also houses class and seminar rooms for art history courses, and the Art Department slide library of 40,000 slides.

Sponsored and Institutional Research. The University received approximately $13.7 million exclusively for sponsored research funding during fiscal year 1982, and ranks nationally as one of the 100 leading universities in terms of sponsored research support. In addition, there are a substantial number of faculty research projects supported, in part, by institutional research committees. Graduate students frequently serve as integral parts of faculty research projects which span a wide range of disciplines.

The George Aiken Lectures. The annual George Aiken lectures, established in honor of Vermont's dean of the United States Senate, focus on issues of national and international importance. They bring together speakers of prominence, University faculty, and the University community to achieve greater understanding of significant human concerns.

The Vermont Seminars. The Vermont Seminars Program augments the focus of teaching and research at the University and enriches educational offerings by bringing to campus individuals from a variety of walks of life, including faculty, statespersons, distinguished citizens, and leaders in special fields.

The George Bishop Lane Artists Series. The George Bishop Lane Artists Series is one of the largest collegiate artists series in the country. It was inaugurated in 1955 by a gift of over $300,000 from the late Mrs. Lane, in honor of her husband, George Bishop Lane of the Class of 1883.

The Lane Series allows the University to bring annually to the campus and the Burlington area a continuing program of outstanding musical, theatrical, dance, and other artistic productions for a moderate admission fee. The Series is planned and produced by an advisory committee comprised of faculty, students, and townspeople.

Support Services for Graduate Students

GRADUATE STUDENT ADVISORY COMMITTEE

The Graduate Student Advisory Committee (GSAC) comprised of graduate student representatives from each of the colleges and schools provides a forum for discussion of graduate student concerns and assists the Dean and the Executive Committee in matters affecting graduate students. Issues considered by GSAC recently range from the academic through professional development and student life. GSAC sponsors a student research day and occasional social events, and conducts a mini-grants program to support, in part, expenses associated with student travel for professional purposes.

Minority Student Program and Center for Cultural Pluralism. The mission of the Minority Student Program is to meet the commitment expressed by the University in terms of creating a more diversified academic community.

Through the Minority Student Program, special tutorial services, as well as non-academic counseling and advising, are provided to students. A newsletter is generated to members of the academic community informing them of program information, career and job opportunities, and other important events.

The Director of MSP, whose office is located at the Center for Cultural Pluralism on Redstone Campus, is the non-academic official for students participating in this program. Personal, social, academic and other concerns are handled through the program and its staff.

The Center for Cultural Pluralism serves as a focal point on campus where students, faculty, administrators and staff can gather and share their cultural heritage through a variety of social, cultural, and educational programs.

Programs range from educational colloquia and ethnic dinners to a campus/community wide Ethnic Heritage Faire Day in the Fall and Ethnic Heritage Month in the Spring.

Center for Career Development. The Center for Career Development provides assistance in establishing placement credential files, interviewing techniques, and resume writing. Center personnel also provide individual assistance in developing job searches. An extensive career

library contains information on full-time positions, along with occupational briefs, job market trends, salary surveys, and company literature. In addition, the office lists limited part-time and summer job opportunities.

Counseling and Testing Center. The Counseling and Testing Center is a campus resource available to students, faculty, and staff. The Center offers confidential individual and group counseling, testing services (including the Graduate Record Examination), and workshops on topics including stress reduction, study skills, assertiveness, and life planning.

Exercise and Wellness. The University's extensive physical education plant is available for recreational use by faculty, staff, and students during hours not devoted to specific instruction. Swimming, handball, skating, tennis, squash, and many other individual and group activities are available for interested participants.

Graduate students may not enroll in physical education classes without prior approval by the Dean of the Graduate College. Graduate College tuition scholarships do not cover any fees for physical education activities.

In addition to the physical education facilities, the University has an active Outing Club. There are many opportunities in Vermont for participation on either an organized or informal level in such activities as hiking, camping, sailing, swimming, skiing, running, bicycling, and other athletic activities.

Areas of Inquiry and Research. Graduate education at the University of Vermont encompasses many areas of inquiry each characterized by a strong emphasis upon independent thinking and writing, research, appropriate practica experiences, and a personable yet challenging teaching environment.

Most graduate programs enjoy a size which allows a critical mass of graduate students but are not so large as to be impersonal. This feature, coupled with the central location of the University on a single campus, contributes greatly to trans-disciplinary cooperation and sharing of research resources. In fact, it is the designed size of our programs and University which affords trans-disciplinary opportunities not usually available at larger institutions. The following broad areas of inquiry arise from the individual graduate degree programs:

- Applied and Behavioral Sciences
- Biomedical Sciences
- Education
- Life Sciences and Natural Resources
- Physical Sciences and Engineering
- Social Sciences and Humanities

APPLIED AND BEHAVIORAL SCIENCES

Graduate degree programs in the Applied and Behavioral Sciences include:

Business Administration	M.B.A.
Communication Science and Disorders	M.S.
Computer Science	M.S.
Human Nutrition and Foods	M.S.
Medical Technology	M.S.
Psychology	Ph.D.

The Applied and Behavioral Sciences span a broad range of disciplines that include individual, societal, and organizational phenomena as the major focus of research.

The graduate program in business is intended to develop management skills that can be broadened and enhanced during the course of the manager's career. It emphasizes training in all functional areas of business, and features close contact between faculty and students.

The Computer Science program at the University of Vermont is housed in the same department as the graduate program in Electrical Engineering which facilitates integration of concepts and operations associated with hardware and software configurations and applications.

Dr. Mitchell Kramer in audiology lab.

The program in Communication Science and Disorders, which trains registered speech pathologists and audiologists, is accredited by ASHA. Research projects include language development and disorders, articulation processes and disorders, fluency management, speech perception, biofeedback, and hearing disorders. The Eleanor Luse Center provides an outstanding setting for clinical training experiences.

The Human Nutrition and Foods program encompasses both basic and applied aspects of human nutrition and food science. There is strong research collaboration among Department faculty, as well as with faculty from the College of Medicine and other departments within the College of Agriculture. Current research interests include nutritional biochemistry, clinical nutrition, food toxicology, food chemistry, diet and cancer, food habits, nutritional status and requirements, and nutrition education.

The graduate program in Medical Technology integrates clinical aspects of the discipline with training of medical technology educators. A wide range of research interests may be pursued within this program, often involving collaboration with faculty members from departments in the College of Medicine, such as Pathology or Medical Microbiology. In addition, the Medical Center Hospital of Vermont provides outstanding training opportunities.

Right: Medical Technology student

The graduate program in Psychology at the University of Vermont offers two major curricula: (1) general and experimental psychology, and (2) clinical psychology.

Research encompassed in the general and experimental area includes topics such as neural substrates of autonomic and somatomotor conditioned emotional response; effects of marijuana on behavior and brain functions in humans and animals; programs for optimizing early development; methodology, measurement, statistical analysis, and computer applications; and biological and psychological rhythms.

The clinical psychology program, accredited by the American Psychological Association, is designed for early placement in a variety of clinical facilities and simultaneous research training. Some of the clinical and research areas of specialization include alcoholism, behavior therapy, family and group therapy, child clinical, human sexual behavior, hypnosis, primary prevention, health psychology, and behavioral medicine.

Harold Leitenberg, *Professor of Psychology and director of the clinical training program,* was selected as the University Scholar in the Humanities and Social Sciences for 1982-83. This honor is in recognition of his contributions to the University in scholarship, research, and graduate education. Dr. Leitenberg has supervised more than 25 doctoral dissertations, served as editor and editorial consultant to major journals, and is currently involved in several research projects in his area of primary interest, behavior therapy.

In each of the disciplines within the Applied and Behavioral Sciences there are generally state-of-the-art instrumentation and laboratories as well as excellent practica and case study facilities.

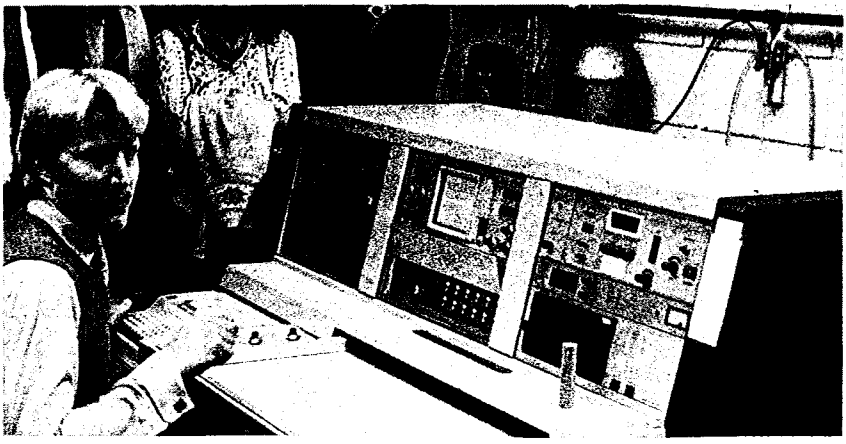
Funding for graduate studies in the form of fellowships and assistantships is available on a competitive basis.

PHYSICAL SCIENCES AND ENGINEERING

PROGRAMS:

Biomedical Engineering
Biostatistics
Chemistry
Civil Engineering
Electrical Engineering
Geology
Materials Science
Mathematics
Mechanical Engineering
Physics
Statistics

Opportunities for graduate study at the Ph.D. level exist in Chemistry, Electrical Engineering, Materials Science, and Mechanical Engineering. The Master of Science is offered in these departments and in Biomedical Engineering, Biostatistics, Civil Engineering, Geology, Mathematics, Physics, and Statistics; Master of Arts in Teaching in Chemistry, Geology, Mathematics, and Physics; Master of Science for Teachers in Geology, Mathematics, and Physical Sciences (Chemistry and Physics).

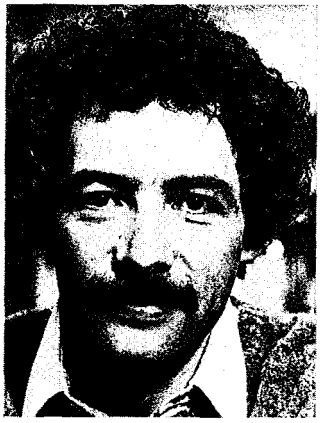


Graduate student operates NMR at dedication of new facility.

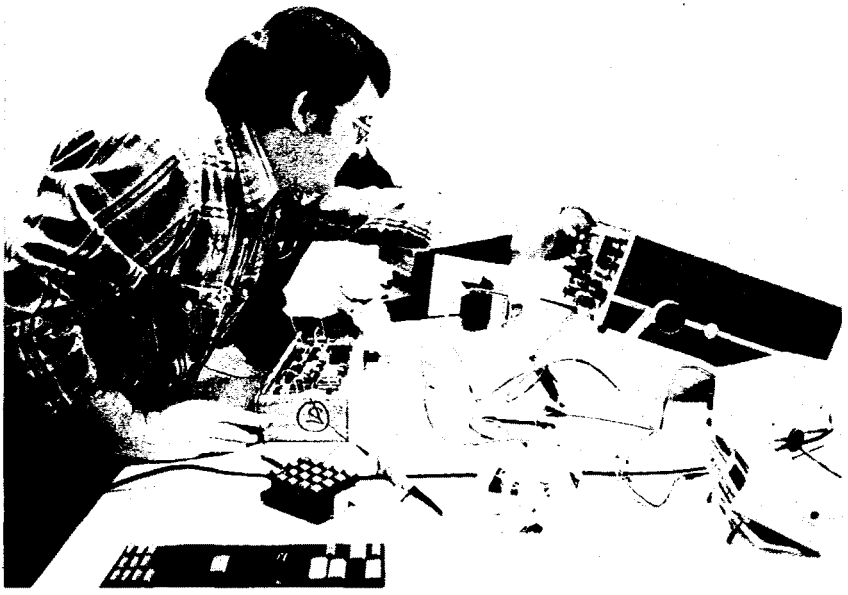
Research and graduate education in the physical sciences and engineering at UVM can involve considerable interaction among the departments as well as with other departments and programs in the University. For example, practicum projects in Biostatistics utilize faculty research in the College of Medicine; anti-cancer drug research in Chemistry is carried out jointly with the Vermont

Regional Cancer Center and the Departments of Pharmacology and Medicine in the College of Medicine; environmental research in Civil Engineering and Geology may involve the School of Natural Resources. At the course work and research levels, Materials Science is an example of interdisciplinary cooperation between the Departments of Chemistry, Electrical Engineering, Mechanical Engineering, and Physics. Research in the program may be conducted in any of the member departments, depending upon student interest and faculty expertise. Close ties with local industry have resulted in co-operative educational programs involving employees from local industries and the Electrical and Mechanical Engineering programs. In addition, UVM hosts a full-time program for mid-career IBM engineers which allows for updating these professionals in the latest Electrical Engineering technology.

Stanley Rush, *Professor of Electrical Engineering* and University Scholar in the Physical Sciences for 1980-81, has a worldwide reputation in the field of electrocardiology. During the course of his research, which has been supported continuously by NIH for 20 years, he has developed the most detailed and complete set of data on body resistivity available. Equipment purchased through research funding has helped make his lab a leader in the simulation of the electrocardiographic process. Prior to joining the UVM faculty, Professor Rush carried out research in private industry and for the federal government, and taught at the university level.



William Geiger, *Professor of Chemistry,* is the 1983-84 University Scholar in the Physical Sciences. Much of his research group's effort focuses on the consequences of electron-transfer reactions for selected types of compounds. The primary techniques are electrochemical, commonly interfaced with spectroscopy and chromatography to help define the mechanisms of the redox processes. Most of the systems studied are inorganic or organometallic, chosen because the redox processes involve formation of potentially interesting or unusual compounds. This research has received consistent support from NSF and other agencies. Professor Geiger held teaching and research positions at other universities prior to coming to UVM and has collaborated with scientists at a variety of institutions in his research.



Student in Engineering lab

Funding for graduate students in the Physical Sciences and Engineering exists in the form of Graduate Teaching Fellowships and Graduate Research Assistantships and is available on a competitive basis. Graduate Teaching Fellows provide teaching experience to students who may teach a section of an introductory course, assist a faculty member with a large course, or instruct laboratory sections. Graduate Research Assistantships typically involve half-time assistance on a faculty research project sponsored by an external agency.

With many of the programs in the Physical Sciences and Engineering at UVM the relatively small size of the departments can offer special educational opportunities for graduate students. Close faculty/student interaction and interdisciplinary opportunities are two of the primary benefits that can accrue to students.

THE BIOMEDICAL SCIENCES

PROGRAMS:

Anatomy and Neurobiology
Biochemistry
Cell Biology
Medical Microbiology
Pathology
Pharmacology
Physiology and Biophysics

The above programs, except for Pathology, offer Master of Science and Ph.D. degrees, and in most instances give preference to qualified applicants seeking the Ph.D. The Pathology program leads to the Master of Science, and interested students may pursue the Ph.D. in Cell Biology in cooperation with the Department of Pathology. Many strong research projects investigating areas at the forefront of modern biology are conducted within the graduate programs in the biomedical sciences at the University of Vermont. Many of the research projects in this area are interdisciplinary in nature and promote close cooperation among faculty from the basic science departments in all colleges at the University, including some of the clinical departments in the College of Medicine. There is a broad range of current areas under investigation, including such varied research as genetic histocompatability, mechanisms of cellular aging, neurochemistry of brain function, energetics of cardiac and skeletal muscle tissue, and tumor biology. Several faculty members in the biomedical sciences have received recognition from the University community through the University Scholar program during the past few years for their outstanding contributions to research, scholarship, and graduate education. Their interest and expertise in specific areas of research are indicative of the over-all quality of scientific investigation within the biomedical sciences at the University of Vermont.

Brooke T. Mossman

Brooke T. Mossman, *Research Assistant Professor of Pathology,* was the 1981-82 University Scholar in Medical Sciences. One research area of current interest to Dr. Mossman involves mechanisms of respiratory carcinogenesis by asbestiform minerals. The risk of bronchogenic carcinoma is increased substantially in asbestos workers who smoke. Using tracheal epithelial cells,

organ cultures and grafts, Dr. Mossman has defined several mechanisms of synergism between PAH (polycyclic aromatic hydrocarbons) and asbestiform fibers. Asbestos serves as a carrier of absorbed PAH to the tracheal epithelial cell and increases cellular uptake of PAH *in vitro* in comparison to levels observed with addition of PAH alone. She is also determining whether asbestos and other fibrous materials act as classical tumor promoters in the respiratory epithelium.

President Lattie F. Coor and Thomas J. Moehring (right).

The 1982-83 University Scholar in the Medical Sciences was **Thomas J. Moehring** *(Professor of Medical Microbiology).* Dr. Moehring is seeking to elucidate the mechanisms by which toxic substances act at the cellular and molecular level. His aim is the development of methods for controlling and even eliminating diseases caused by a variety of toxic materials. The action of diphtheria toxin in cell culture systems is used as the model in this research. Dr. Moehring is also using toxins as molecular probes in studies to learn more about the biology of the cell under conditions of normal and abnormal growth. For example, techniques of biochemical and genetic analysis are being used to characterize the mechanisms by which cells internalize, process, and respond to biologically active agents — such as toxins, hormones and viruses — that must enter cells to elicit a cellular response or complete their cycle.

James F. Clapp, III

The most recently selected University Scholar in the Medical Sciences is **James F. Clapp, III** *(Professor of Obstetrics and Gynecology).* For several years Dr. Clapp's research has centered upon the effects of environmental factors (e.g. altered substrate availability, maternal exercise, maternal drug ingestion) on fetal growth and development. Dr. Clapp's current investigations center around fetal-maternal interactions during placental insufficiency. He has developed a

chronic pregnant sheep model to study the pathophysiology of this state. The significance of Dr. Clapp's research is recognized throughout the medical research community. He presently holds the prestigious Research Career Development Award from the National Institutes of Health, awarded nationally to distinguished scientists.

Each of the laboratories in the biomedical science departments is well equipped, including state-of-the-art instrumentation, micro and/or networked computer resources, and highly trained technical assistants.

For further information concerning departmental programs, specific areas of research, or individual faculty members please consult the Graduate College Catalogue entry for the appropriate department.

Funding for graduate students in the form of teaching fellowships and research assistantships is available on a competitive basis.

LIFE SCIENCES AND NATURAL RESOURCES

The University of Vermont offers exceptional opportunities for graduate study in diverse aspects of the Life Sciences and Natural Resources. Degree programs offered include:

Agricultural and Resource Economics	M.S.
Animal Sciences	M.S., Ph.D.
Botany	M.S., Ph.D.
(including the interdisciplinary Field Naturalist M.S. option)	
Cell Biology (interdisciplinary)	M.S., Ph.D.
Forestry	M.S.
Microbiology and Biochemistry	M.S., Ph.D.
Natural Resource Planning	M.S.
Plant and Soil Science	M.S., Ph.D.
Wildlife and Fisheries Biology	M.S.
Zoology	M.S., Ph.D.

In addition, students may pursue the Masters of Arts in Teaching (M.A.T.) in Botany or Zoology, or the Master of Science for Teachers (M.S.T.) in Biology (Botany and Zoology).

Faculty research interests and expertise range from the molecular to community and ecosystem dynamics. Laboratories house state-of-the-art instruments while Lake Champlain and the University's Natural Areas provide unique settings for field studies.

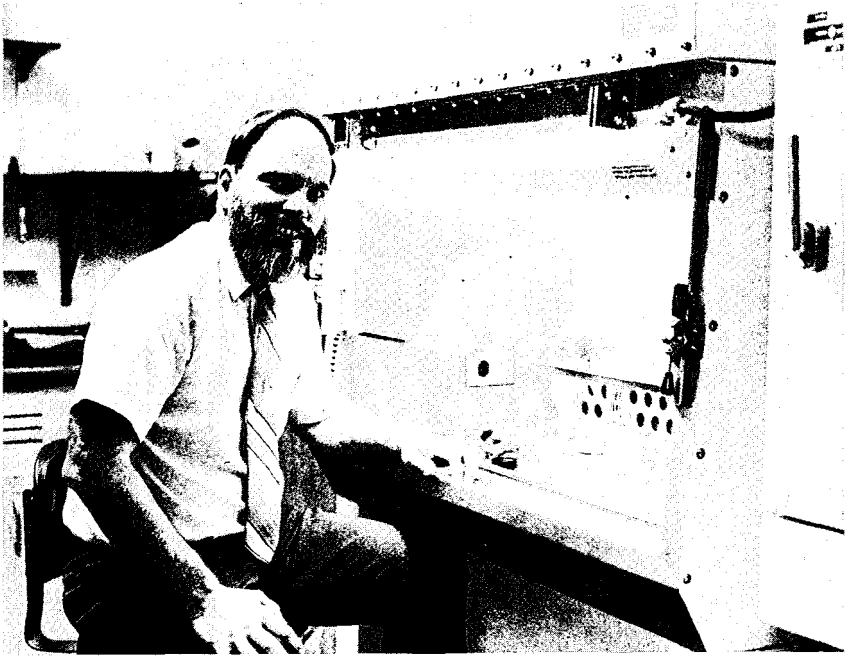
Outstanding contributions of the Graduate Faculty to research, scholarship, and graduate education are recognized by the Graduate College through the University Scholar Awards program. Since the inception of this program in 1980-81, UVM's University Scholars in the Biological Sciences include Professors George M. Happ (Zoology), Robert C. Ullrich (Botany), and Alexander H. Duthie (Animal Sciences).

Dr. George M. Happ

George M. Happ describes his research activities: "My research concerns insect development and reproduction. Our laboratory studies cell differentiation in accessory glands of male mealworm beetles. The secretions of these glands nourish the sperm and also enclose the seminal mass in a protein envelope for transfer to the female. With surgery and organ culture, we ask how hormones regulate cell cyles, affect ultrastructure, and control patterns of

protein synthesis in the developing glands. This model system is convenient material for analyses of mechanisms of hormone action and for investigation of the physiology of insect reproduction."

Robert C. Ullrich is probing the genetic control of development. He summarizes the current work in his laboratory: "Recombinant DNA technology allows us to study how cells regulate the expression of their genetic material in order to attain differentiated states and foster the development of the organism. We are interested in diverse aspects of fungi as important organisms in the industry, biotechnology and ecology of our society. A particular set of important genes in the higher fungi, e.g., in *Schizophyllum commune,* has attracted our attention. These genes regulate 30-50 other genes located throughout the hereditary material of the fungal nucleus. We couple knowledge from classical genetic experiments with that from contemporary techniques to study the complex molecular interactions through which the regulatory genes control the hierarchy of developmental genes. In addition to contributing basic information about the genetics of higher organisms, we suspect that the information gleaned will ultimately be applied to control the rust and smut diseases that decimate world production of cereal grains. This is an extremely rewarding endeavor; it permits us to enjoy the incentives of both basic and applied research."



Dr. Robert C. Ullrich

Dr. Alexander H. Duthie

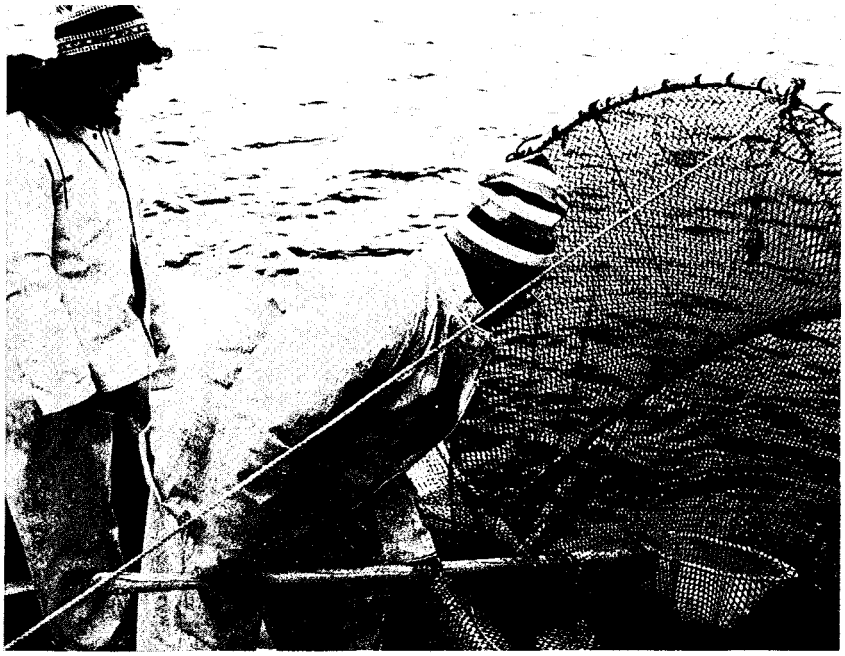
Alexander H. Duthie is very active in dairy research. The Dairy Flavor Research group at the Department of Animal Sciences in the College of Agriculture has been conducting studies in areas such as sensory evaluation, lipid methodology, development of dairy foods, and quality management tests. Most recent findings in the laboratory were the development of a test to quantify nonesterified fatty acids in milk, and a discovery that many consumers preferred lipolyzed milk. These findings have resulted in patent discussions for an invention and a process. The test is being used to establish nonesterified fatty acid profiles for activation treatments that cause rancid flavor of milk; a different profile for each treatment could be used as a fingerprint to help dairy workers rapidly identify the cause of a rancid milk supply. In addition, the research group recently received a grant from Dairy Research Incorporated of the United Dairy Industry Association to develop a new test that will detect fat adulteration of dairy foods.

Research activities in the life sciences at the University of Vermont span many traditional disciplines, from the basic medical sciences to agriculture, forestry, human nutrition, animal sciences, wildlife and fisheries biology, botany, and zoology. Interdisciplinary, intercollege pursuits are facilitated by the size of the University and faculty interest in collaboration.

Research interests are equally as varied in resource areas, including regional planning, rural development, landscape asessment, water resources, wildlife and fisheries biology, resource economics, forest management, remote sensing, and computer applications. Interactions with faculty from departments such as Geography, Geology, Computer Science, and Civil Engineering as well as those in the Life and Biomedical Sciences add to the quality and diversity of studies in Natural Resources.

Funding for graduate students in the form of teaching fellowships and research assistantships is available on a competitive basis.

Students with Trap Net



EDUCATION AND SOCIAL SERVICES

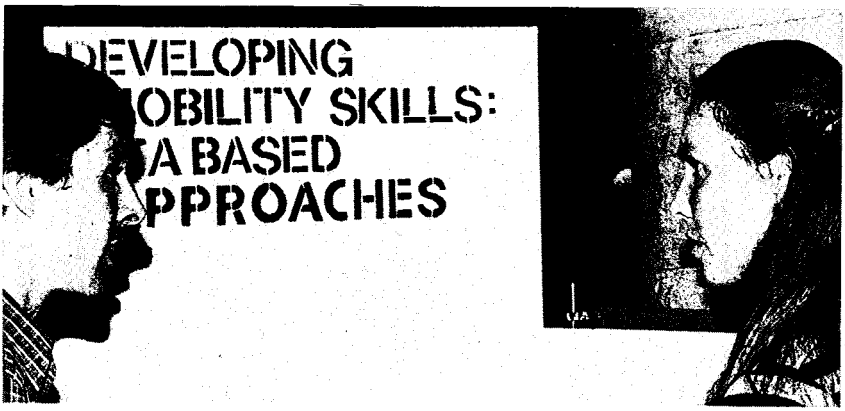
The College of Education and Social Services prepares students for careers in education and social services by providing opportunities to attain appropriate critical knowledge and relevant professional skills. The College offers graduate preparation programs in many phases of elementary and secondary education, curriculum and instruction, special education, higher education, administration, counseling, reading, school library media, and educational leadership. Specific degrees and certificates include the Master of Education, the Master of Science in Counseling, Certificates of Advanced Study, and the Doctor of Education. Graduate programs are designed to meet state educational certification requirements.

The College of Education and Social Services also offers a variety of special workshops, instructional institutes and other in-service education and service activities designed to enhance professional effectiveness and to improve agency delivery systems. It serves the State by offering courses at off-campus locations and providing service to working professionals.

James Peterson, *Professor of Organizational, Counseling, and Foundational Studies,* in addition to his counseling of students, has done extensive work in counseling couples and families. His current interests include applications of neurolinguistics in the communications process and implications of culture and values in counseling. In addition to his teaching and writing, he provides workshops for couples, parents, families, and professional helpers.

Professor James Peterson

Faculty research interests and research opportunities for graduate students are extensive and include studies in learning disabilities, life span human development, cognitive development, effective schools, equality of educational opportunity, effective teaching, computer applications, research evaluation, instructional analysis, and rural school development.



Above: Graduate student Ruth Hamilton (r) discusses results of research conducted while an intern with the Center for Developmental Disabilities.

The Center for Developmental Disabilities engages in a variety of research projects related to improving the quality of life and services provided such individuals. For example, the Center is currently focusing upon projects for improving services provided to parents of individuals with developmental disabilities and facilitating the social integration of school-age learners with severe handicaps in school and other community settings. Through the parent project, the Center is investigating procedures for improving parent and school cooperation, providing parents with the knowledge and skills to teach their children in home and community settings, and transitioning high school-age individuals with developmental disabilities from public schools to adult services. Within the social integration project, the Center is researching procedures for increasing appropriate interactions between handicapped and non-handicapped individuals in school and community settings.

Graduate students are encouraged to take an active role in designing their program of study. Graduate students are supported personally and professionally by a faculty advisor throughout their graduate study. Small classes offer special educational opportunities for graduate students and the greater Burlington area offers exceptional professional field experiences and cultural activities. Funding for graduate students in the form of graduate fellowships and assistantships and Graduate College Fellowships is available on a competitive basis.

A recipient of the Kidder Award for outstanding teaching, **Professor Betty Boller** did her doctoral work in history, philosophy, and comparative education at Harvard. During her more than 20 years at UVM, she has inspired thousands of educators and human service providers in her popular courses. Currently, she teaches graduate courses in philosophy of education and modes of inquiry.

Professor Betty Boller

HUMANITIES AND SOCIAL SCIENCES

PROGRAMS:

English
French
Geography
German
Greek and Latin
Historic Preservation
History
Political Science

Graduate programs in the humanities and social sciences are at the master's degree level. The departments listed above all offer both the Master of Arts and Master of Arts in Teaching, except for Political Science which offers the Master of Arts only. Historic Preservation, a professional program within the Department of History, offers the Master of Science. In general, these graduate programs enroll small numbers of students. At the same time, faculty expertise and library and other resources in many of these areas are diverse and teaching and research are of high quality. Departmental information in the catalogue and information maintained for prospective students by individual departments chronicles the breadth of opportunities available.

Wolfgang Mieder, *Professor of German,* was selected University Scholar in the Social Sciences and Humanities for 1980-81. He has authored 11 books in his research specialty, paremiology and folklore, since 1972, and has produced numerous scholarly articles as well. In addition to his scholarly work, he currently serves as Chairman of the Department of German and Russian, and as co-editor of a folklore journal. An excellent teacher and contributor to graduate education, Professor Mieder also finds time to lecture to community groups and schools.

Wolfgang Mieder

Robert Daniels, *Professor of History* and 1981-82 University Scholar in the Social Sciences and Humanities, is an expert on the Soviet Union and Eastern Europe. He is the author of a dozen books and numerous articles on a wide range of scholarly topics, and his scholarship has received support from, among

other sources, the Rockefeller Foundation and NEH, and a Guggenheim Fellowship. In addition to his active research, teaching, and involvement in graduate education, Professor Daniels has served UVM as Chairman of the Department of History and as Director of both the Center for Area Studies and the Experimental Program. He has served the State of Vermont as a member of the State Senate, where he held the position of minority leader.

Robert Daniels

Fellowship funding for students in humanities and social sciences programs is available on a competitive basis in the form of Graduate Teaching Fellowships and Graduate College Fellowships (see p. 59, respectively). Teaching Fellowships provide opportunities for obtaining valuable classroom experience (and generally result in two years being required to obtain the master's degree). College Fellowships, having no duties associated with them, allow for additional time for study and more rapid completion of course work towards the degree.

The Degree Programs of the Graduate College

The Graduate College offers the following degree programs:

MASTER OF ARTS

Programs are offered in the following fields:

English
French
Geography
German
Greek and Latin
History
Political Science
Psychology

MASTER OF SCIENCE

Programs are offered in the following fields:

Agricultural and Resource Economics
Animal Sciences
Biochemistry
Biomedical Engineering
Biostatistics
Botany
Cell Biology
Chemistry
Civil Engineering
Communication Disorders
Computer Science
Counseling
Electrical Engineering
Engineering Physics
Forestry
Geology
Historic Preservation
Human Nutrition and Foods
Materials Science
Mathematics
Mechanical Engineering
Medical Microbiology
Medical Technology
Microbiology
Natural Resource Planning
Pathology
Pharmacology
Physics
Physiology and Biophysics
Plant and Soil Science
Statistics
Wildife and Fisheries Biology
Zoology

MASTER OF BUSINESS ADMINISTRATION

Study leading to the MBA is designed to provide opportunity for the individual to develop knowledge and understanding in a wide range of business activities that will provide a foundation for growth and success in a business career.

MASTER OF EDUCATION

The Master of Education degree is designed to give those who work in education the background and professional preparation needed for leadership in teaching and related functions. Programs are planned with special attention to the following areas:

- Administration and Planning
- Foundations of Education
- Occupational and Practical Arts
- Organization and Human Resource Development
- Reading and Language (Elementary and Secondary)
- Special Education
- Student Personnel Services in Higher Education
- Teacher 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:

- Botany
- Chemistry
- English
- French
- Geography
- Geology
- German
- Greek and Latin
- History
- Mathematics
- Occupational and Practical Arts
- Physics
- Zoology

MASTER OF SCIENCE FOR TEACHERS

This degree is designed primarily for secondary school teachers already certified who wish to strengthen their backgrounds in their subject matter fields, and who desire flexibility in choosing courses at levels best suited to their needs.

- Biology (Botany & Zoology)
- Geology
- Mathematics
- Physical Sciences (Chemistry & Physics)

Consult departmental listings for prerequisites and minimum degree requirements.

MASTER OF EXTENSION EDUCATION

This degree is for persons with educational responsibilities outside of regular school settings. Programs are individually designed to provide knowledge and competencies associated with a career field. Emphasis is placed upon preparation for educational leadership functions. Programs are planned in the following specializations:

Agricultural Agencies and Organizations
Business and Industry
Youth Organizations

DOCTOR OF EDUCATION

The degree of Doctor of Education (Ed.D.) is offered in Educational Administration. The program is based upon applied research and coursework, and is designed for in-place, upper level educational administrators in schools or related organizations.

DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy (Ph.D.) is offered in:

Anatomy and Neurobiology
Animal Sciences
Biochemistry
Botany
Cell Biology
Chemistry
Electrical Engineering
Materials Science
Mechanical Engineering
Medical Microbiology
Pharmacology
Physiology and Biophysics
Plant and Soil Science
Psychology
Zoology

CERTIFICATE PROGRAMS

The following certificate programs are offered for post-baccalaureate study by the College of Education and Social Services. They do not lead to a graduate degree and are not offered by the Graduate College. Interested persons are encouraged to contact directly the Dean's Office of the College of Education and Social Services for further information.

FIFTH YEAR CERTIFICATE IN EDUCATION

A program culminating in a fifth year certificate is offered by the College of Education and Social Services for students seeking work beyond the bachelor's degree. It is designed to meet the needs of teachers who are developing new teaching fields, advanced students who are meeting requirements for state certification, and 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 Social Services.

Persons enrolled in the fifth year certificate program transferring to Master of Education programs are subject to Graduate College policies on validation of credit outlined on page 42.

CERTIFICATE OF ADVANCED STUDY

A Certificate of Advanced Study (sixth year certificate), a 30-36 graduate credit hour program beyond the master's degree, is offered by the College of Education and Social Services in the following fields:

a. Administration and Planning, which is designed to prepare administrators and planners for public schools, educational and social agencies, and middle management positions in higher education.
b. Counseling. Individuals who have completed a master's degree in counseling or a related area may apply for admission to the C.A.S. program. The program is designed to further develop skills in counseling, consultation, and program planning and coordination.
c. Integrated Studies, which is an inter-area program designed for students who have completed their master's degree and are interested in exploring a self-designed, integrated program of study drawing upon graduate level experiences currently provided by departments of Organizational, Counseling, and Foundational Studies; Special Education, Social Work, and Social Services; Professional Education and Curriculum Studies; Physical Education, Health and Learning Studies of the College of Education and Social Services and other University departments. The program is under the general administration of the Dean of the College of Education and Social Services with direct supervision by a committee of representative faculty from the participating areas within the college.
d. The Consulting Teacher/Learning Specialist concentration prepares leadership personnel for special education. Applicants must possess the master's degree in special education and have at least two years of leadership experience. The course sequence is individualized according to the applicant's background and needs and leads to a Certificate of Advanced Study. The concentration includes 30 credit hours of coursework selected from the following: EDSP 301, 310, 312, 316, 322, 323, 384, and 385.

CERTIFICATE IN RUSSIAN AND EAST EUROPEAN AREA STUDIES

A specialization in the area, leading to a Graduate Certificate, may be obtained in conjunction with a master's degree program in a particular discipline. The program is designed to serve as a foundation for doctoral study with specialization in the area; for teaching in the area at the secondary level; or for employment in internationally-oriented organizations. Requirements are 30 credit hours of study in the area, of which up to 18 could simultaneously be counted toward the master's in a discipline. For details, contact the Center for Area and International Studies.

CONCURRENT DEGREE PROGRAMS: M.D./M.S. AND M.D./Ph.D.

Post-sophomore fellows in medicine who have been accepted into a Graduate College program are permitted to apply credit from appropriate medical courses in which a letter grade of A, B, or C is earned toward an M.S. or a Ph.D. degree. Such students are enrolled in the Graduate College for one or more years to pursue research and enroll in those courses that normally are not included within their medical program of study. While such persons are working toward both an M.D. and M.S. or Ph.D., completion of each degree need not occur at the same time.

Policies of the Graduate College

Persons applying to a graduate degree program are urged to consider future employment opportunities in their proposed field of study. Specific information regarding employment prospects may be obtained on request from the appropriate department chairperson.

APPLICATION PROCEDURES AND ADMISSION

To be eligible for admission an applicant must hold a baccalaureate degree prior to the date of first enrollment or have completed work equivalent to that required for a baccalaureate. The undergraduate record must indicate a capacity for successful study at the graduate level. Satisfactory scores on the Graduate Record Examination are required for most degree programs (see departmental and program listings) and for all persons applying for fellowship support. All applicants from unaccredited institutions must present satisfactory scores on the general (aptitude) and subject (advanced) portions of the GRE. International students, see special instructions on page 37.

Admission is limited to individuals who intend to become candidates for advanced degrees, other than Doctor of Medicine, and whose enrollment will include courses to be taken for graduate credit. Students who hold bachelor's degrees but whose entire enrollment will be in courses which do not carry graduate credit must enroll as non-degree students through the Division of Continuing Education.

Only applicants interested in and qualified for graduate programs will be admitted to the Graduate College. Admission to the Graduate College does not mean that a student is also accepted automatically as a candidate for the advanced degree. In many departments, acceptance to candidacy occurs only after the enrolled student has completed successfully some of the requirements of the degree program.

The Graduate College makes provision for students with a baccalaureate to take graduate level courses on a non-degree basis. Such students are generally individuals who do not desire to pursue a degree program but merely wish to expand their knowledge in certain areas. It is not necessary to make formal application for admission to the Graduate College in order to take courses. Non-degree students who have not been admitted into the Graduate College are limited to a total of six course credit hours per semester. A non-degree student who has accumulated nine credit hours of graduate study at the University must seek approval for further enrollment from the Dean of the Graduate College.

Individuals seeking formal admission to the Graduate College must make application on an official form which can be obtained from the Graduate College Admissions Office. All applications must be supported by two 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. Admission requirements regarding the submission of specific standardized test scores (e.g., Graduate Record Examinations and Graduate Management Admissions Test) are listed under the appropriate program requirements section beginning on page 65. Applications and associated correspondence must be sent directly to the Graduate College Admissions Office.

All applications for admission must be accompanied by a $20 application fee which is non-refundable.

When to apply. The deadline for receipt of completed applications and supporting materials for admission for the fall semester is *April 1* for most departments, except that a *February 1* deadline is required for the Psychology program, and a *March 1* deadline for the Historic Preservation Program and to applicants for the Doctorate in Education (Ed.D.). GRE scores from applicants to the Ed.D. must be received by no later than April 1. The part-time program of study in Psychology is open only to Vermont residents. Most departments process applications soon after *all* of the supporting information is received in the Graduate College Admissions Office. Applications will *not* be processed after the openings in a program have been filed. Therefore, for fall admission, it is important to file applications well in advance of April 1 as some programs can accommodate only a limited number of new graduate students.

It is sometimes possible to admit new graduate students at midyear; however, such applications should be initiated at least three months in advance of the date the study is to begin.

Students who wish to be considered for financial assistance in the form of fellowships or assistantships as well as admission must have applications with all supporting materials including GRE scores on file by *March 1* of the academic year preceding that for which application is made. Applications for fellowship or assistantship assistance *must* include GRE General (Aptitude) Test and the appropriate Subject (Advanced) Test scores. No special forms are required to apply for Teaching, Research, or Graduate College Fellowships, and Graduate Assistantships. Applicants interested in such awards must so indicate on the appropriate section of the application form. Student Personnel Fellowships must be applied for on a separate form through the Department of Residential Life, Robinson Hall. Information on loans and/or work-study is available through the Financial Aid Office, Waterman Building.

Standard Graduate Admission Tests. Applicants for admission to most graduate programs must submit scores on the Graduate Record Examination (see specific program requirements). Business Administration applicants must submit scores on the Graduate Management Admissions Test.

Information about standard graduate admission tests may be obtained from the Counseling and Testing Center, University of Vermont, or from any college testing office. Information on the Graduate Record Examination or the Graduate Management Admissions Test may also be obtained directly from the Educational Testing Service, Box 889, Princeton, N.J. 08541.

All applicants requesting fellowship or assistantship support must submit scores on the Graduate Record Examination or Graduate Management Admissions Test prior to March 1. Arrangements to take the standard graduate admission test must be made by no later than January 1984 so that test results will be available by March 1.

Health Record. The University requires that students maintain a personal health record with the University Health Service. This is accomplished by completion of the DASH health form ($9 fee) at the time of first enrollment. Persons with special medical problems or those wishing to submit an alternate health record must consult the University Health Service.

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

INTERNATIONAL STUDENTS

The Graduate College welcomes qualified applicants from other countries. A full-time Advisor for international students is available to provide counseling and assistance to international students (graduate and undergraduate) and international faculty on personal matters, and issues relating to compliance with the U.S. Immigration and Naturalization regulations. An active campus International Club provides an opportunity for international students and scholars to contribute to campus life and to make American friends outside the classroom.

Application Procedures

1. International applicants interested in applying to the University for a particular graduate program must request a Preliminary Application (pre-application) Form from the Graduate College Admissions Office. Upon receipt of this completed pre-application form, a formal application will be mailed if an appropriate program of graduate studies is available for the applicant's area of intended study. Early application will help compensate for the delays caused by overseas mailings.

2. Applicants from countries where English is not the principal language of instruction must submit scores from the Test of English as a Foreign Language (TOEFL) in addition to those from the Graduate Record Examination (GRE). Scores from both the general (verbal and quantitative) and appropriate subject (advanced) sections of the GRE must be submitted. Information on these examinations may be obtained from the Educational Testing Service, Box 889, Princeton, NJ 08541.

3. All application materials including test scores, transcripts, and letters of recommendation must be submitted as early as possible to the Graduate College, preferably by December 1 of the year prior to enrollment, to insure adequate time to process the application.

In addition to application materials, international applicants must submit evidence of independent financial support (approximately $10,000 U.S. per year) in the form of a signed statement from a bank or scholarship source. This information should be submitted to the Graduate College Office as early as possible; prospective graduate students are urged to send such information at the time of pre-application.

Financial Aid. Information on fellowships and assistantships begins on page 59. These awards are based upon academic performance. Teaching fellowships require proficiency in the English language. Fellowship, assistantship, and traineeship awards are *extremely* competitive, especially for first year students. Generally, International Students may be considered for these awards only after satisfactory completion of one year of graduate studies at the University of Vermont.

For information concerning eligibility criteria and application procedures for programs administered by the Institute of International Education, a student may contact the U.S. Embassy, Consulate, or Information Service in his or her country.

Students from Africa, the Middle East, Korea and other areas may also request information about scholarships from the following:

For Africa: The African-American Institute, 833 U.N. Plaza, N.Y., NY 10017. For the Middle-East: American Friends of the Middle East, Inc., Middle East House, 1607 New Hampshire Ave., N.W., Washington, DC 20009. For Europe, South America, and South East Asia: Institute of International Education, 809 U.N. Plaza, N.Y., NY 10017. For South and Central America: LASPAU, 25 Mount Auburn Street, Cambridge, MA 02138.

New England Regional Student Program. An opportunity for qualified legal residents of New England states to enroll at reduced tuition rates (currently 125 percent of resident tuition) for programs which are not offered by the home state university but are offered in another New England state is available under an arrangement entitled the New

England Regional Student Program. A list of available graduate programs may be examined in the Graduate College Dean's Office or obtained from the New England Board of Higher Education, 45 Temple Place, Boston, MA 02111 at $2 per copy.

Applicants must indicate clearly, both in their initial inquiries and on their application forms, that they are seeking admission under the terms of the New England Regional Student Program. In cases where the program of study is clearly unique or distinctive to the out-of-state institution, the UVM Graduate College Dean's Office will certify directly the applicant's eligibility to apply under the New England Regional Student Program. In cases where an apparently similar program of study is available at both institutions involved, the graduate deans of the two institutions will determine whether regional student status is appropriate.

Maximum Time Limits for Degree Completion

MASTER'S DEGREE	
Full Time Student	3 Years
Part Time Student	5 Years
DOCTORAL DEGREE	
All Students	9 Years

Individual departments may set deadlines within these time limits. *It is important that students complete their programs within the time limits specified. Further educational opportunities or employment responsibilities alone will not justify delay in program completion.*

ENROLLMENT AND COLLEGE REQUIREMENTS

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

Enrollment Guidelines. The range of normal full-time graduate enrollment for non-funded students is nine-12 hours; maximum enrollment is 15 hours per semester. The normal range of full-time enrollment for students on fellowships or assistantships is six to 10 hours. Following completion of all credit requirements, enrollment for *Continuous Registration* is equivalent to full-time enrollment, when the student is studying full-time at the University completing degree requirements.

Change in Enrollment. Any change in enrollment must be approved in writing in advance by the student's advisor and authorized by the Dean of the Graduate College. Specific regulations regarding the adding, dropping, or withdrawing from courses are available from the Registrar. The

exact dates may be found in the schedule of courses, available at the Graduate College Dean's Office, or from the Registrar. Course change forms may be obtained from the Department, Registrar, or Graduate College Dean's Office.

Continuous Registration. A student who has completed satisfactorily all coursework and research credit required in the degree program, but has not completed all degree requirements (for example, comprehensive exam, defense of thesis or dissertation) must enroll for Continuous Registration (see p. 55 Fees). Enrollment for Continuous Registration may be accomplished by mail or in person through the Graduate College Dean's Office.

Auditing Courses. Courses may be taken for audit; however, the credit hours are charged as usual. Under no circumstances will credit or grade be allowed for courses audited. *Tuition scholarships which are funded by the Graduate College and accompany fellowship awards do not cover courses enrolled for audit.*

Summer and Evening Study. Information regarding graduate course offerings and enrollment may be obtained from the Division of Continuing Education. Enrollment in such courses for graduate credit does not indicate admission to the Graduate College.

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

Undergraduate Enrollment for Graduate Credit. UVM senior undergraduates may enroll for graduate credit at UVM under the following circumstances: the course must be available for graduate credit; total enrollment including the graduate course must not exceed 12 credit hours in the semester in which the course is taken; the course must not be computed as part of the bachelor's degree; permission to seek such graduate credit must be requested of the Dean of the Graduate College in writing by the Dean or Director of the undergraduate college or school prior to enrollment for such credit. Such graduate credit is limited to six hours, and is not available for transfer to another institution as graduate credit. It can be used only at UVM if and when the student is admitted to a UVM graduate program and only if the course is judged appropriate by the student's advisor for the participating graduate program.

College Requirements. Each student is expected to be familiar with the requirements and procedures of the Graduate College and with the specific degree requirements in the chosen field of study. The following requirements define the parameters within which the Graduate College functions. Specific guidelines for each department must be consulted in

addition to these general requirements. Upon first enrollment in the Graduate College, each student will receive the Graduate College Handbook which details further University and College procedures to satisfy requirements for advanced degrees.

In unusual circumstances, a student may appeal any of the Policies of the Graduate College by written request to the Dean of the Graduate College and the Executive Committee of the Graduate College.

Acceptance and Candidacy for Advanced Degrees. Applicants for the master's degree may be admitted to graduate studies or accepted to candidacy for the degree concurrent with admission. Acceptance to candidacy for the master's degree is granted only to those students who have met fully all undergraduate course prerequisites required for the graduate degree program and all departmental requirements for candidacy (e.g., coursework, examinations, professional certification where applicable). The approval of the department and the Dean is required for concurrent admission and acceptance to candidacy.

Candidacy for the doctoral degree requires a full year of graduate study in residence at the University of Vermont. A doctoral student is accepted to candidacy upon the approval of the student's Studies Committee, the department or departments concerned, and the Dean of the Graduate College.

PREVIOUS CREDIT

Graduate level course credit acquired at UVM and elsewhere prior to formal admission to the Graduate College may, within limits, be applied toward advanced degree requirements. ***The total limits apply to credit earned by transfer, validation, or examination, or any combination thereof.*** The maximum number permitted is nine for a master's degree or 24 for the Ph.D. No course credit acquired prior to formal admission to the Ed.D. program may be applied toward the degree requirements.

Transfer of Credit. Upon request from the department and approval by the Dean of the Graduate College, transfer of credit for appropriate courses completed at other institutions after completion of a baccalaureate degree may be accepted toward completion of degree requirements. *In cases where such transfer is approved, it is the credit only and not the grade which is accepted for transfer.* A maximum of nine hours credit in the case of master's candidates and 24 hours in the case of Ph.D. candidates may be accepted in transfer. 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 taken prior to the completion of a baccalau-

reate degree, (2) courses which would not, if taken at the University of Vermont, receive graduate credit, (3) courses in which a grade lower than B (3.00) was received, (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 date of completion of degree requirements for a master's program or nine years for a Ph.D. program, (7) thesis or dissertation credits received at another university.

Validation of Credit. To insure effective planning of a graduate program, *not more than nine hours of graduate credit acquired at the University of Vermont as a non-degree student prior to admission to the Graduate College may be validated on a student's record as applicable toward the credit requirements of an advanced degree.* Validation of credit is subject to the same restrictions as stated for transfer of credit. If an applicant is enrolled as a non-degree student in appropriate graduate courses during the semester in which the application is approved for admission, these credits, up to a maximum of six hours, will also be applied to the degree program and will not reduce the number of validation credits available.

Credit by Examination. A student may, under certain circumstances, receive credit for a course by taking an examination. A fee of $25 per credit is charged for each examination for credit.

CONCURRENT MASTER'S AND DOCTOR OF PHILOSOPHY CREDIT

Up to 24 hours of coursework for which graduate credit is earned at UVM in a master's degree program, whether a master's degree is received or not, may be applied toward a Ph.D. at UVM provided they are appropriate for the Ph.D. program.

No provision is made for a person to employ the same credit to satisfy two master's degrees at the University of Vermont.

Minimum Residence Requirements. The residency requirement is completed by courses that (1) are taken for graduate credit through the University of Vermont either in the academic year or in summers on the main campus or at off-campus locations, and (2) are taken after the student has been admitted to the Graduate College. Each candidate for the master's degree must satisfactorily complete 21 hours in residence. Each candidate for the Ph.D. degree must satisfactorily complete a minimum of 51 hours in residence. Residency requirements for candidates for the Ed.D. are detailed on page 52.

Some programs may require more than the above minimum hours in residence, and consultation with the department chairperson is advised.

Teaching Requirements. All degree candidates must acquire appropriate teaching experience in their chosen fields prior to the awarding of the 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 departments concerned.

Language Requirements. The language requirements may be completed by (1) satisfactory performance on the Educational Testing Service's Foreign Language Examination which is offered three times a year on campus (All candidates will submit their registration forms and fees directly to the Graduate Schools Foreign Language Tests, Educational Testing Service, Princeton, NJ 08541. Further information may be obtained from the Counseling and Testing Center, University of Vermont.), or (2) an examination may be requested by the student's department and administered by it or in conjunction with the appropriate language department.

If the department substitutes competence in computer literacy, it may normally be achieved by satisfactory completion of Computer Science 11 and 241 or by satisfactory completion of an examination (on a pass-fail basis) set and graded by the staff of the Academic Computing Center. Individual departments may set additional requirements.

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 or Dissertation Research and may be used to indicate levels of performance in Seminar. There are no quality points associated with the letter grades of S and U.

A candidate for a graduate degree must complete the program with a minimum overall grade point average of 3.00. For the purpose of determining a grade point average, the following applies: A+, 4.00; A, 4.00; A−, 3.67; B+, 3.33; B, 3.00; B−, 2.67; C+, 2.33; C, 2.00; C−, 1.67; F, 0.00. A course may be repeated for credit only when failed and only once; only the second grade is then considered. Both grades remain on the student's transcript.

A student may be dismissed from the Graduate College if two grades or more below a B, or the designation of U in Thesis or Dissertation Research or Seminar are received.

The designation *"Inc"* or *"I"* applies to work of acceptable quality when the full amount is not completed because of illness or emergency. It can be awarded only with the prior permission of the Graduate College Dean. The Dean may set the limit of time when the work of the course is to be completed. In no case shall this time be set longer than the beginning of the corresponding semester of the next academic year.

Extended Course. The grade of XC is awarded at the end of the

semester to a student who is enrolled in an identified course the nature of which makes it unreasonable or impossible for the student to complete the required work within the regular semester.

Students withdrawing from courses after the date prescribed by the Registrar will receive a grade of WP — withdrawn passing, or WF — withdrawn failing, dependent upon the quality of work completed. The grade WP does not enter into the grade point average (GPA). The grade of WF enters the GPA as an F.

Graduate students may elect to take an undergraduate course on a satisfactory (S)-unsatisfactory (U) basis provided permission is obtained, prior to enrollment, from the Department Chairperson and the Dean of the Graduate College and a letter grade is not required by the Studies Committee for evaluation. Courses at the 200 level or above other than Seminar or Thesis/Dissertation Research may not be taken on a satisfactory (S)-unsatisfactory (U) basis for graduate credit.

Professional Ethics and Academic Honesty. Graduate students are required and expected to adhere to a high standard of professional responsibility. The University policy on academic honesty, applicable to graduate students, is reprinted in full in the Graduate College Handbook which is given to each new graduate student. Graduate students are responsible for familiarizing themselves with this policy, and additional copies of the Graduate College Handbook are available in the Graduate Dean's Office.

Studies Committees for Master's and Doctoral Programs. Each student enrolled in either a master's or a doctoral degree program is eligible and required to have a Studies Committee or its equivalent as soon as possible after enrollment. The equivalent to the Studies Committee is permitted in those departments which employ an alternative procedure that has been approved by the Graduate College.

MASTER'S DEGREE STUDENTS:	See p. 46 for specific information.
DOCTORAL DEGREE STUDENTS:	See p. 52 for specific information.

Master's Thesis or Doctoral Defense Examination Committee. Master's degree candidates in programs requiring a thesis and those in other degree programs who elect to complete a thesis, as well as all doctoral degree candidates must prepare and submit the thesis/dissertation in compliance with the detailed "Guidelines for Writing a Thesis or Dissertation" available from the Graduate College Office. The Defense Examination Committee is responsible for evaluating the thesis or dissertation and also the candidate's performance in defending the work.

MASTER'S DEGREE CANDIDATES: See p. 47 for specific information.

DOCTORAL DEGREE CANDIDATES: See p. 54 for specific information.

Program Outline. Every graduate student must complete a program outline upon completion of *nine credit hours of graduate work* for those students pursuing a master's degree and *18 credit hours of graduate work* for those students pursuing a doctoral program, regardless of whether such credits have been earned at UVM or elsewhere, as long as such credits are intended to be applied, if acceptable, to the degree requirements for a particular student. The program outline, completed on a form available from the Graduate Dean's Office, is an aid to planning and may be amended during the course of the student's studies as appropriate.

Leave of Absence. An approved leave of absence (up to a maximum of 12 months) suspends the time limit for degree completion for the duration of the leave. Students must obtain the approval of their Department or Program Chairpersons and the Dean of the Graduate College on a form available in the Graduate Dean's Office prior to the leave of absence in order to be considered on approved leave. A leave is not permitted for those who have completed all course and research credit requirements.

Withdrawal from Degree Program. Students must notify the Graduate College in writing of their intent to withdraw from a degree program. However, if a student does not register at the University of Vermont for course work, thesis or dissertation research, or continuous registration for a period of more than one calendar year, and does not notify the department or the Graduate College in writing, the student will be considered to have withdrawn from the degree program. It will be necessary to apply for reactivation and pay a reactivation fee (p. 56) if the student wishes to resume the graduate program.

Conferral of Graduate Degrees. Degrees are conferred only at commencement at the end of each academic year. If a student has completed all degree requirements prior to that time, a letter will be issued certifying that the graduate degree program has been completed and that the degree will be conferred at the next commencement.

REQUIREMENTS FOR MASTER'S DEGREES

All master's degree programs require a minimum of thirty semester hours of graduate credit. Departments and individual programs may require additional hours. In programs that require a thesis, the number of

credit hours to be earned in thesis research may vary between six (minimum) and 15 (maximum); these credits are included in the minimum of 30 required for the degree.

MASTER OF ARTS AND MASTER OF SCIENCE

Field of Specialization. At least 21 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 21 hours must have been earned in courses which have been approved for graduate credit.

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 Studies Committee of the department in which the student is specializing.

Studies Committee. It is the responsibility of the Studies Committee to supervise the graduate student's program and to review progress at regular intervals. A Studies Committee is appointed by the department chairperson or designated departmental representative and approved by the Dean of the Graduate College as soon as possible following enrollment as a duly admitted student of the Graduate College, unless the student's department employs an alternative approved procedure. The Chairperson of the Studies Committee serves as the student's academic advisor and also as the thesis advisor or supervisor. In order to direct a master's thesis a faculty member must either be a regular member of the Graduate Faculty or obtain the approval of the Chairperson and the Graduate Faculty of the department or program to direct the specific master's thesis. In the latter case, the Chairperson will notify the Graduate College Office of the particular departmental action *prior* to the student's beginning work on the thesis research.

A Studies Committee for a student pursuing a master's degree consists of at least three faculty members with one of the members from outside the candidate's department or program. At least two of the Committee members must be regular members of the Graduate Faculty. For master's degree programs with a thesis, the three members of the Studies Committee will usually constitute the Thesis Defense Examination Committee providing the outside member is a regular member of the Graduate Faculty. The outside member will then serve as the Chairperson of the Thesis Defense Examination. If the outside member is not a regular member of the Graduate Faculty, then such an additional person will be appointed by the Dean of the Graduate College to serve as the Chairperson of the Thesis Defense Examination Committee based upon the nomination(s) submitted by the student's advisor (see p. 47).

Language Requirement. Certain departments require a reading knowledge of an appropriate foreign language. The methods of satisfying the language requirement are described on page 43.

Comprehensive Examination. A written and/or oral comprehensive examination is required in the field of specialization. If both formats are used, satisfactory completion of the written examination is prerequisite to standing for the oral examination. All comprehensive examinations are taken on the University of Vermont campus in Burlington. One reexamination only is permitted for any final comprehensive examination.

Research and Thesis. If a thesis is required, the candidate will undertake a problem of original research under the supervision of a member of the Graduate Faculty in the department of specialization. At the conclusion of the investigation the student must present a thesis which embodies the results of the work and demonstrates capability for independent research.

A thesis must be prepared and submitted in compliance with the detailed "Guidelines for Writing a Thesis or Dissertation" available from the Graduate College Office. The oral Defense Examination of the thesis can be scheduled only *after* successful completion of the comprehensive examination *and* submission of an original copy of the thesis to the Graduate College Office for preliminary review of the thesis by the Dean of the Graduate College. The original copy of the thesis must be submitted to the Graduate Dean *at least two weeks prior* to the scheduled oral defense. Individual departments may require earlier deadlines. The student must provide copies of the thesis or dissertation to the members of the Defense Examination Committee at least two weeks before the scheduled examination.

Thesis Defense Examination Committee. Upon receipt of a completed thesis, the candidate's advisor will nominate to the Dean of the Graduate College a Thesis Defense Examination Committee for the oral Defense Examination of the thesis by the candidate. The Thesis Defense Examination Committee is usually identical in composition to the Studies Committee and consists of at least three faculty members, at least two of whom must be regular members of the Graduate Faculty. Ordinarily, two committee members will be from the candidate's department or program and the third member will be from another department or program at the University of Vermont or another person approved by the Graduate Dean based upon the nomination of the thesis advisor. If the representative from outside the candidate's department or program is not a regular member of the Graduate Faculty, a regular member of the Graduate Faculty will be added and designated as the Chairperson of the Thesis Defense Examination Committee by the Dean of the Graduate

College based upon the nomination of the student's advisor. The acceptability of the thesis is determined by the Thesis Defense Examination Committee.

The Chairperson of the Defense Examination Committee has the responsibility for ensuring proper conduct of the examination, appropriate documentation of the results, and that the signatures of endorsement are added to the signature page of the thesis or dissertation following a successful defense. If the candidate's Defense Examination performance is not satisfactory, then only one examination is permitted.

Three copies of the corrected thesis must be forwarded to the Dean of the Graduate College after the successful defense of thesis, within the time period specified by the Thesis Defense Examination Committee.

MASTER OF BUSINESS ADMINISTRATION

Management is the art of applying principles of the mathematical and social sciences to decision making in an organizational environment characterized by uncertainty and limited resources. The program is designed (1) to develop the individual's ability to practice the art and (2) to build a foundation that will facilitate and encourage the continuation of this development beyond a formal university setting. Courses in the program emphasize the understanding and critical evaluation of conceptual and theoretical principles relevent to the decision process in the functional areas of business.

Upon completion of the program, students will have been exposed to each functional area, will have been required to demonstrate an ability to engage in individual and group research projects, and will have demonstrated capacity to present coherently and defend their views orally and in writing.

Examinations

A written comprehensive examination is administered as part of the Business Policy course; and covers all functional areas of business.

MASTER OF EDUCATION

For admission to a Master of Education program, the applicant must present satisfactory scores for the Graduate Record Examination (General portion) at the time of application for admission. Before the degree is awarded, the candidate must have completed one year of successful teaching experience or other educational service. This requirement may be fulfilled by satisfactory completion of student teaching, an internship, or a practicum.

The graduate program of each student admitted to candidacy for the degree of Master of Education is planned and supervised by an advisor in

the respective program area. Program planning is based upon the student's undergraduate curriculum, professional experience, and aims and purposes in pursuing the master's degree.

Each program must include a minimum of either 30 semester hours of approved course work or 24 hours earned in courses and six hours in thesis research. Contingent on a candidate's background and interests and on program specification, additional credit hours may be required. If a student's preparation is inadequate to begin study at the graduate level, additional undergraduate courses will be required. Each Master of Education degree program must include a minimum of six semester hours of graduate work in the foundations of education unless this requirement or its equivalent has been met previously. Graduate courses which currently fulfill this requirement include: EDFS 204, 205, 206, 209, 252, 302, 303, 354, and EDSS 313 and EDLS 377.

To insure effective planning of a graduate program for the degree of Master of Education, no more than nine hours credit will be accepted in partial fulfillment of degree requirements for courses taken prior to acceptance to the Graduate College. See Previous Credit, p. 41.

Comprehensive Examination

A comprehensive examination is required. However, it may be written, oral, or both. The choice of the examination format will be made by faculty members in the area of specialization after consultation with the advisor and the candidate.

a. The written comprehensive examination will cover the field of education with emphasis on the area of specialization.

b. The oral comprehensive examination will emphasize the area of specialization.

All examinations are taken on the University campus in Burlington. Only one re-examination is permitted for any final comprehensive examination. It is the responsibility of the candidate to schedule the required examination with the College of Education and Social Services. Since each program has different options for meeting the oral and written comprehensive requirements, candidates must contact the respective program chairperson or advisor regarding program policy.

If the thesis option is elected, there must be an oral examination in defense of the thesis. (See Thesis Defense Examination Committee, p. 47, listed under Master of Arts and Master of Science, for defense examination requirements).

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 backgrounds in their subject matter fields. Each MAT program requires close cooperation between the specialist department and the College of Education and Social Services. Students with questions regarding the education component of their program must consult with the College of Education and Social Services Dean's Office. GRE scores are required for admission.

A minimum of 30 semester hours is required in courses numbered above 200, of which not fewer than six semester hours shall be in education courses taken at the University of Vermont. This is a non-thesis program. A student must complete at least 21 hours, in either a single department offering courses for graduate credit or in any acceptable combination of such departments. To be accepted to candidacy for this degree, a student must have completed an undergraduate major within the areas of specialization, and be acceptable to the departments concerned.

Candidates are expected to have completed the necessary courses in education to meet minimum requirements for a teaching certificate during their undergraduate programs. 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, candidates must present at least 18 semester hours in education in their combined undergraduate and graduate programs. This requirement is specified to ensure that degree recipients can meet minimum certification requirements. Students without prior teaching experience will be required to complete satisfactorily an internship or an equivalent field experience which may be graded and which will be in addition to the minimum MAT education course requirements. This internship or field experience will be an essential prerequisite to consideration for certification.

Comprehensive Examination

a. A written comprehensive examination in the field of education.
b. A written or oral comprehensive examination in the field of specialization. The choice between written or oral examination is 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. It is the responsibility of the candidate to notify the respective department and the College of Education and Social Services to schedule the required examinations.

MASTER OF SCIENCE FOR TEACHERS

Refer to specific department listings for requirements for this degree program.

MASTER OF EXTENSION EDUCATION

A minimum of 30 semester hours in courses numbered above 200 is required. At least 12 semester hours will be completed in the College of Agriculture, including at least six semester hours in education courses offered by the College of Agriculture. A minimum of 18 additional semester hours will be selected to meet individualized program objectives. Normally, no thesis is required.

The candidate may complete the degree requirements through Summer Session, Evening Division, and/or full-time residency. A candidate will be expected to spend at least one semester or a minimum of two summers in residence at the University of Vermont campus in Burlington.

Satisfactory scores on the GRE General test is required for admission. Before the degree is awarded, the candidate must have completed the equivalent of one year of professional experience. This requirement may be completed by an internship or practicum experience approved by the candidate's studies committee.

Comprehensive Examination

a. A written comprehensive examination in the field of specialization.
b. A comprehensive oral examination in the field of specialization.

Satisfactory completion of the written examination is prerequisite to standing for the oral examination. All comprehensive examinations are taken on the University of Vermont campus in Burlington. One re-examination is permitted for any final comprehensive examination.

REQUIREMENTS FOR DEGREE OF DOCTOR OF EDUCATION (Ed.D.)

The Ed.D. is offered in Educational Administration only. It is an applied research-based program, primarily for professionals serving in educational management positions.

Prerequisites for Admission to Graduate Studies. Applicants must possess a master's degree from an accredited institution and a cumulative grade point average of 3.00 for previous graduate study. Other requirements include satisfactory scores on the General Test of the Graduate Record Examination (GRE) and a representative writing sample.

Students admitted to graduate studies must complete successfully the four core courses in Tier I. Upon such completion and submission of a

qualifying paper, students will be considered for candidacy for the degree (Tier II).

Prerequisites for Acceptance to Candidacy for the Degree of Doctor of Education. Satisfactory completion of all requirements for Tier I and the qualifying paper will satisfy the prerequisites for acceptance to candidacy.

Requirements for the Degree of Doctor of Education include a minimum of 56 semester credit hours of doctoral studies completed at UVM following formal admission to the program with the following distribution.

Tier I — 12 semester hours in the four core courses (year 1)
Tier II — 24 semester hours (minimum)
Dissertation Research — 20 semester hours (minimum).

All course credit hours beyond Tier I are distributed in administration and planning, humanities, research and statistics courses, and clinical studies. Cognate courses in other UVM departments may be included in individual programs.

Residency Requirement. The residency requirement for the Doctor of Education (Ed.D.) degree consists of the following:
1. Completion of the four core courses (12 semester hours) during the first academic year following acceptance to the program, *and*
2. Completion of 12 semester hours of coursework (excluding dissertation research) during *one* academic year within Tier II.

For further requirements concerning Studies Committees, Research and Dissertation, and the Dissertation Defense Examination Committee refer to the following section, Requirements for the Degree of Doctor of Philosophy (Ph.D.)

Application deadline is March 1 (GRE scores must be received by April 1).

REQUIREMENTS FOR DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D.)

The degree of Doctor of Philosophy requires a minimum of 75 credit hours to be earned in courses and in dissertation research.

Studies Committee. It is the reponsibility of the Studies Committee to supervise the graduate student's program and to review progress at regular intervals. A Studies Committee is appointed by the department chairperson or designated departmental representative and approved by the Dean of the Graduate College as soon as possible following enrollment as a duly admitted student of the Graduate College, unless the student's department employs an alternative approved procedure. The Chairperson of the Studies Committee serves as the student's academic

advisor and also as the dissertation advisor or supervisor. In all usual cases, only a regular member of the Graduate Faculty can serve as an advisor of a doctoral dissertation. On occasion, it may be appropriate for a professional other than a regular member of the Graduate Faculty to serve as a member of a Studies Committee or a Defense Examination Committee. In such cases, written approval of such a member must be obtained from the Dean of the Graduate College *prior* to the student's beginning dissertation research.

A Studies Committee for a student pursuing a doctoral degree will consist of at least six faculty members with two of the members from outside the candidate's department or program. Ordinarily, all committee members will hold regular membership on the Graduate Faculty. The Studies Committee will usually constitute the Dissertation Defense Examination Committee. One of the members from outside the department or program will serve as Chairperson of the Dissertation Defense Examination Committee as appointed by the Graduate Dean based upon the nomination of the student's advisor.

Courses. A minimum of 15 hours in courses used in compilation of the grade point average must be taken in residence at the University of Vermont. The first year of each doctoral program consists almost entirely of required courses; in the following years appropriate courses are selected by the candidate in consultation with the Studies Committee. Details of each doctoral degree program can be obtained from the appropriate department chairperson or from the Dean.

Language Requirements. The determination of language requirements is established by each individual department. Please refer to specific departmental regulations. If knowledge of a foreign language is required, the method of satisfying this requirement, including evaluation of proficiency, will be determined by each individual department.

The language requirement must be fulfilled before the written comprehensive examination is taken and before admission to candidacy.

Comprehensive Examination. A comprehensive written examination in the field of study must be passed by the candidate at least six months before the dissertation 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.

Success in the written comprehensive examination is prerequisite to standing for the oral Dissertation Defense Examination. All examinations are taken on the University campus in Burlington.

Research and Dissertation. Each candidate, while in residence at the University of Vermont, must complete an acceptable original research project which contributes new knowledge or techniques in an academic

field. Each candidate must enroll in a minimum of 20 credits of dissertation research. In all usual cases, only a member of the Graduate Faculty may supervise dissertation research for the Ph.D. or the Ed.D.

A dissertation must be prepared and submitted in compliance with the detailed "Guidelines for Writing a Thesis or Dissertation" available from the Graduate College Office. The oral Defense Examination of the dissertation can be scheduled only *after* successful completion of the comprehensive examination *and* submission of an original copy of the dissertation to the Graduate College Office for preliminary review of the dissertation by the Dean of the Graduate College. The original copy of the dissertation must be submitted to the Graduate Dean *at least two weeks prior* to the scheduled oral defense. Individual departments may require earlier deadlines. The student must provide copies of the dissertation to the members of the Defense Examination Committee at least two weeks before the scheduled examination.

Dissertation Defense Examination Committee. Upon receipt of a completed dissertation, the Dean of the Graduate College will appoint a Dissertation Defense Examination Committee based upon nominations submitted by the candidate's advisor. The Dissertation Defense Examination Committee usually consists of at least six individuals who are regular members of the Graduate Faculty, although in exceptional cases a non-member may be approved by the Dean of the Graduate College. At least one of the two Dissertation Defense Examination Committee members from outside the candidate's department or program *must* be a regular member of the Graduate Faculty and is designated Chairperson of the Dissertation Defense Examination Committee by the Graduate Dean. The acceptability of the dissertation is determined by the Dissertation Defense Examination Committee.

The Chairperson of the Defense Examination Committee has the responsibility for ensuring proper conduct of the examination, appropriate documentation of the results, and that the signatures of endorsement are added to the signature page of the thesis or dissertation following a successful defense. If the candidate's Defense Examination performance is not satisfactory, then only one examination is permitted.

Four copies of the corrected dissertation must be forwarded to the Dean of the Graduate College after the successful defense of dissertation, within the time period specified by the Dissertation Defense Examination Committee.

Educational and Living Expenses

Tuition. Rates for the 1983-84 academic year will be as follows: For Vermont residents, $100 per credit hour, $1,193 flat rate for 12 hours, and $100 per credit hour in excess of 12 hours.

For non-residents of Vermont, $262 per credit hour, $3,132 flat rate for 12 hours, and $262 per credit hour in excess of 12 hours.

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

GRADUATE STUDENT FEES

Application Fee. All applications for admission must be accompanied by a $20 application fee. This fee is non-refundable.

Continuous Registration Fee. A fee of $100 per semester is charged each graduate student who has paid tuition for all credits required in the degree program but who has not completed all degree requirements in order to maintain continuous enrollment.

Library and Athletic Bond Fees. A library fee of $17 and an Athletic fee of $24 are required of each student enrolled for 12 credit hours or more in any given semester. These fees are assessed by legislative act and fund the debt retirement on the bond issues which funded construction of these facilities.

Part-Time Comprehensive Fee. Students enrolled in fewer than 12 credit hours pay a Comprehensive Fee in lieu of the Library and Athletic fees according to the following schedule: 0-3 (including CRF), no fee; 4, $20; 5, $24; 6, $28; 7, $32; 8, $36; 9-11, $40.

Student Health Fee. A fee of $54 per semester is charged all degree students enrolled at the University for 12 credit hours or more. Students enrolled for fewer than 12 credit hours will be eligible for University Health Services by paying this fee. *Student Accident and Sickness Insurance* — Through an arrangement with a commercial insurance company, students are able to procure health insurance which is designed to provide coverage for services beyond those provided by the University Health Service. There is an additional charge for this extended coverage beyond the student health fee. The 1983-84 cost for one year's coverage for single students is $94. Married students may obtain coverage for their

spouse and children. Further details are available from the University Health Service. To participate in this insurance, the student health fee must be paid each semester as well as the additional insurance premium.

Reactivation Fee. Reactivation following withdrawal without an approved leave of absence requires payment of a $25 reactivation fee.

Advanced Degree Fee. The fee charged to each advanced degree recipient is as follows:

Doctoral Degree	$25
Master's Degree (With thesis)	20
Master's Degree (Without thesis)	10

This fee may be paid at any time but must be paid prior to the deadline established for submission of Doctoral dissertations or Master's theses for each of the three graduation periods.

It is the responsibility of the degree candidate to pay the appropriate advanced degree fee at the Graduate College Office, 335 Waterman, in order to have a degree awarded.

Penalty Payments. Students who are allowed a payment postponement of all or a portion of their financial obligation will be charged a $50 late payment service charge. There is also a late enrollment fee of $10.

Student Housing and Living Expenses. A limited number of University owned apartments are available for married full-time students. Located just outside Winooski on Route 15 at Fort Ethan Allen, these apartments are on a bus route five miles from the main campus. Detailed rental information may be obtained from the Ethan Allen Housing Office, 600 Dalton Drive, Winooski, VT 05404. Telephone (802) 656-3228.

A limited number of University owned apartments for single graduate students are available at Fort Ethan Allen. These spacious apartments will each accommodate approximately eight students. Rent for the period from September 1, 1983 through May 22, 1984 will be $1,744 per person for a double room and $2,026 for a single. This includes all utilities except telephone. A nine-month lease and $50 deposit are required. Summer occupancy is available at the option of the student and at additional cost. Free and frequent transportation to and from campus is provided. Detailed rental information may be obtained from the Ethan Allen Housing Office listed above.

Up-to-date listings for available apartments, houses, and rooms for rent in the area are maintained by the Department of Residential Life. This service allows community landlords and rental agents to make known housing opportunities to persons associated with the University. Students may also examine listings at the Billings Center or on a bulletin

board just off the College Street entrance of Waterman Building on the main campus. The University is not responsible for the approval of off-campus housing facilities. A catalog of available listings is issued each May, August, and December and may be viewed at the Office of Residential Life, Robinson Hall, Redstone Campus, University of Vermont, Burlington, VT 05405. Telephone (802) 656-3434. Rents in the Burlington area vary from approximately $40 per week for a single furnished room to $400-$500 or more per month for a two-bedroom apartment. A single student should expect minimum overall living expenses of approximately $500 per month. If desired, meals may be obtained in University dining halls.

Bill Adjustment. A refund of 100 percent will be processed for reductions effected prior to the start of the semester; an 80 percent refund will be in effect for reductions in enrollment taking place from the first day of classes through the end of the add/drop period (third week of classes); a refund of 40 percent will be allowed for reductions during the fourth and fifth week of classes; no refund will be processed thereafter. At the end of the semester, an audit will be made of each student's record. If the audit reveals that total credit hour enrollment is greater than at the end of the specified drop period, the student will be financially liable for the total enrollment. Students will be charged for all hours as specified in policy statements regarding tuition.

Withdrawals. A student may voluntarily withdraw from the University by notifying the Graduate Dean and the Registrar. Withdrawal for reasons of health requires the approval of the University physician. In either case, the student will receive a refund in accordance with the bill adjustment policy. Date and time of withdrawal normally will be the date the withdrawal notice is received by the Registrar.

Dismissal. If a student is suspended or dismissed, a refund will be processed according to the bill adjustment schedule.

Death. In case of death of the student, tuition which has been paid for the semester during which the death occurs will be fully refunded.

Definition of "Vermont Resident"

Adoped by the Board of Trustees, December 14, 1979; amended June 13, 1981; and effective July 1, 1981.

The Vermont Legislature has established a lower rate of tuition for students who are Vermont residents. Such a policy appears to have as its objective the attempt to more evenly distribute the cost of operating and supporting the University of Vermont between Vermont residents whose taxes have previously supported the University and non-residents who have not done so.

The Legislature has stated that enrollment at an institution for higher learning or presence within the State for purpose of attending an institution of higher learning shall not constitute residence for tuition purposes.

The following requirements must be met by a student prior to being granted resident status for the purpose of admission, tuition, and other University charges:

1. The applicant shall be domiciled in Vermont, said domicile to be continuous for one year prior to the commencement of the semester next following the date of application. Changes in residency status shall become effective for the semester following the date of application. There shall be one date designated each year for the commencement of each semester and the summer term. A semester shall commence on the day classes *begin* for that semester. The summer term shall commence on the day classes *begin* for the summer term.
2. Domicile shall mean a person's true, fixed and permanent home, to which he/she intends to return when absent. A residence established for the purpose of attending an educational institution or qualifying for resident status for tuition purposes shall not of itself constitute domicile. Domicile shall not be determined by the applicant's marital status.
3. The applicant must demonstrate such attachment to the community as would be typical of a permanent resident of his/her age and education.
4. Receipt of financial support from the applicant's family will create a rebuttable presumption that the applicant's domicile is with his/her family. A student who is the child of divorced parents, where the non-custodial parent or joint custodial parent has been domiciled in Vermont for 12 consecutive months immediately prior to application, and such a parent has contributed in excess of 50% of said child's support during at least that period, may be granted In-State status. Certified copies of such parent's IRS returns may be required.
5. An applicant becoming a student at an institution of higher learning in Vermont within one year of first moving to the state shall have created a rebuttable presumption of residence in Vermont for the purpose of attending an educational institution.
6. Eligibility to enroll as a resident student in another state shall create a rebuttable presumption against eligibility to be enrolled at the Unviersity of Vermont as a "Vermont Resident."
7. A student enrolling at the University of Vermont shall be classified by the Residency Officer (designated by the President), as a resident or a non- resident. The decision by the Residency Officer shall be based upon information furnished by the student and other relevant information. The Residency Officer is authorized to require such written documents, affidavits, verifications or other evidence as he/she deems necessary.
8. The burden of proof in all cases rests upon the student claiming to be a Vermont resident and shall be met upon a showing of clear and convincing evidence.
9. The decision of the Residency Officer on the classification of a student as a resident or non-resident, may be appealed in writing to the **Residency Appellate Officer** whose decision shall be final.

Fellowships, Assistantships, and Traineeships

Students who wish to be considered for fellowships as well as admission must submit completed applications, with supporting materials, by March 1 *of the academic year preceding that for which application is made. All applicants requesting fellowship, assistantship, or traineeship support must submit scores received on the Graduate Record Examination.*

Application for fellowships must be made by completion of the appropriate section on the application form. No separate form is required except where indicated herein.

Tuition scholarships accompanying Graduate Teaching, College, Research, and Student Personnel Fellowships do not cover physical education courses and activities and cover courses numbered below 200 only upon prior approval of the Graduate Dean.

GRADUATE COLLEGE FELLOWSHIPS

The Graduate College offers 10 fellowships in support of master's degree programs in the social sciences and humanities. Five fellowships provide a stipend (currently $3,000) and a full tuition scholarship (36 credit hour maximum) for the degree program. The remaining five fellowships provide the full scholarship only.

These fellowships are open to prospective students in the social sciences and humanities at the time of application. Holders of Graduate College Fellowships are expected to carry full-time enrollment towards an advanced degree. The fellowships are not renewable.

GRADUATE TEACHING FELLOWSHIPS AND GRADUATE RESEARCH FELLOWSHIPS

Graduate Teaching Fellowships are awarded in many of the departments offering graduate work. Graduate Teaching Fellows are generally appointed for nine months with stipends averaging $5,400 for the current year. Teaching Fellows may enroll for a maximum of 10 hours per semester. In addition to the stipend, the fellowship award includes a tuition scholarship covering the number of hours specified in the award letter but not to exceed 10 hours per semester during the period of the fellowship.

Graduate Research Fellowships are awarded in some of the science departments offering graduate work. Research Fellows are appointed for nine or 12 months and receive stipends generally ranging from $5,400 (9 months) to $6,900 (12 months) and a tuition scholarship (see limits in Teaching Fellowship description). A maximum of half-time assistance in the department is expected of Graduate Teaching and 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 or Research Fellow is a candidate for the doctoral degree, at least four calendar years must be anticipated for completion of the academic program. Generally, fellows are appointed in the departments in which they are doing graduate work.

Appointments will be announced on or about the first week in April.

STUDENT PERSONNEL FELLOWSHIPS

Graduate students are also eligible to apply for Student Personnel Fellowships. The candidates selected to fill these positions will normally be assigned administrative and advisory positions in the residence halls, although limited opportunities in other student services areas are available as well. Student Personnel Fellows have the opportunity to gain valuable experience in the areas of group advising, administration, personal advising, and educational programming. Such positions are open to either married or single students who have been accepted for graduate work in any of the academic programs of the University of Vermont. Selection is based upon academic record, character, recommendations, and quality of related experiences. A personal interview is required. Student Personnel Fellows receive a stipend of $5,400 plus a tuition scholarship covering a maximum of 10 credit hours per semester for a nine-month period. Room and board is deducted from this stipend for those persons holding Fellowships in the residence halls. Requests for applications and additional information should be addressed to Office of Residential Life, Robinson Hall. Applications received after March 1 will be considered only for unanticipated openings. Appointments will be announced on or about May 1.

GRADUATE ASSISTANTSHIPS

Graduate Assistantships are generally available when a department member receives a grant from a source external to the University. The appointment may be for either nine or 12 months at a starting salary of about $7,400 and $8,900 per appointment period. Part of the salary is for tuition at the in-state rate with a maximum enrollment of 10 credit hours each semester and six credit hours during the summer session.

A maximum of one-half time assistance on the research project is ex-

pected and more than one academic year will be necessary for the completion of the master's degree and at least four calendar years for completion of the doctoral degree. For information on the availability of an assistantship, contact the chairperson of the department concerned.

GRADUATE TRAINEESHIPS

Graduate traineeships are available in certain departments through grants from various state and federal agencies. Traineeships are available currently to graduate students enrolled in the following departments: Biochemistry, Communication Science and Disorders, and Psychology. These traineeships generally carry stipends and include payment of tuition. The chairperson of the department concerned should be contacted for information on the availability of these awards.

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 Chairperson of the Department of Animal Sciences.

HUMPHREY CHEMICAL COMPANY FELLOWSHIP IN HYDROCARBON SYNTHESIS AND GEICO FELLOWSHIP

These fellowships are awarded annually to qualified students in the Chemistry Department working toward a Ph.D. The amount of the stipend is consistent with University policy determined by the Graduate College Office.

OTHER FELLOWSHIPS

A limited number of fellowships established by private donors are available periodically in selected departments.

Financial Aid

The University provides, through the Office of Financial Aid, long-term loans and/or work-study jobs for students based upon demonstrated need remaining after all assistantships, fellowships, traineeships and any other sources of financial aid are considered.

LOANS

National Direct Student Loans are available dependent upon the level of federal allocation to the University. NDSLs are interest-free while the student is enrolled at least half-time in a degree program; repayment of principal and interest at the rate of five percent begins when the loan goes into repayment status.

Guaranteed Student Loans may be obtained through private lenders, generally banks, and are not part of the financial aid award provided by the University. Students are eligible to borrow a maximum of $5,000 per year, depending upon need, up to a total of $25,000. This latter total includes any GSLs received as an undergraduate. Guaranteed Student Loans are interest-free while the student is enrolled at least half-time in a degree program. The interest rate is nine percent and repayment begins six months after leaving school or reducing enrollment to less than half-time.

PLUS Loan Program (also known as ALAS) funds are available up to a maximum of $3,000 per year, with a total maximum of $15,000. In the case of students who also borrow from the Guaranteed Student Loan Program, those funds will be considered a resource and subsequently reduce the dollar amount of eligibility for a PLUS Loan. Repayment of interest begins 60 days following receipt of the loan check. The interest rate is 12 percent, and principal payments may be deferred until completion of full-time studies.

WORK-STUDY

The College Work-Study Program (CWSP) provides financial assistance through employment on campus or with certain kinds of off-campus agencies. Every effort is made to place students in jobs related to their field of study, interest, and skills. The amount of CWSP assistance committed reflects the degree of financial need, a reasonable projection of the amount it is possible to earn at a rate of pay commensurate with the

student's skills and experience, and the total CWSP funds available.

Additional information and application forms are available from the Office of Financial Aid, 330 Waterman Building. Only one application is needed in order to apply for either type of aid, as the applicant is able to indicate on the application if one or the other, or both are preferred.

Interested students are encouraged to contact the Office of Financial Aid to obtain and complete a Guaranteed Student Loan Application shortly after acceptance to graduate study since time is required for the processing of financial aid applications and awards. Generally, the University is unable to fund the full level of student need through the NDSL and CWSP. As a result, it may be necessary for the student to meet an initial level of need through the GSL program prior to the offer of NDSL and CWSP assistance.

FINANCIAL AID REFUND POLICY

For students receiving financial aid, change in student status or credit hour load may result in revision or loss of that financial aid, depending on the regulations of the particular aid programs involved. Except when aid program regulations specify otherwise, any such change which reduces the student's University charges will usually result in reduction of the financial aid award. Such reduction of aid will usually require immediate repayment of the aid so reduced.

VETERANS BENEFITS

Students who are eligible to receive educational benefits from the Veterans Administration should obtain advice from the Center for Career Development.

Courses of Instruction

Course Numbering

Courses numbered 400 or above are limited to candidates for the degrees of Doctor of Education and Doctor of Philosophy; courses numbered 300 to 399 are limited to graduate students; courses numbered 200 through 299 are advanced courses for undergraduates which may also be taken for graduate credit by graduate students. To obtain graduate credit the graduate student generally is expected to meet higher qualitative and/or quantitative expectations than the undergraduate student. Courses numbered 100 to 199 may not be taken for graduate credit except upon recommendation of a student's Studies Committee and with the authorization of the Dean of the Graduate College prior to enrollment. Authorization will be limited to one appropriate course (three credit hours) for a master's program and to two appropriate courses (six credit hours) for a doctoral program. Graduate students may take additional 100-level courses beyond these values, but graduate credit will not be allowed for such courses. Graduate programs designed for the Master of Science for Teachers degree (M.S.T.) are exempted from this rule. Non- degree students are not permitted to receive graduate credit for courses numbered 100-199. Under no circumstances will graduate credit be allowed for a course numbered below 100.

The form 201, 202 indicates that two such courses may be taken independently for credit.

The form 201-202 indicates that such courses 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 course description that follows.

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.

Graduate Degree Programs and Courses of Instruction

AGRICULTURAL AND RESOURCE ECONOMICS

Professors Sargent, Sinclair, Tremblay, and Webster (Chairperson); Associate Professors Fife, Gilbert, and Pelsue; Assistant Professor Bancroft; Extension Professors Bevins and Houghaboom.

The department conducts research in agricultural production economics, marketing, and business management. It also has an active research program in the economics of recreation, regional planning and rural development, rural land use and taxation, and environmental quality and control.

The department offers options in two areas: Agricultural Economics and Resource Economics. Students interested in rural planning may select either option. Each student selects an option and then develops, with a studies committee, an academic program.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

For the agricultural economics option: an undergraduate degree in agriculture, economics, business administration, or a related area. For the resource economics option: an undergraduate degree in resource use, economics, recreation, forestry, or in the natural sciences.

All students must present satisfactory scores on the general (aptitude) Graduate Record Examination. Transcripts are evaluated on an individual basis.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Students who are deficient in key subject areas or where transcript grades appear to be marginal may be required to complete satisfactorily certain courses before acceptance as a degree candidate.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in agricultural and resource economics, general economics, or related fields, 21 to 24 hours, thesis research six to nine hours, for a total of 30 hours.

COURSES OFFERED

201 Farm Business Management. Organization and operation of successful farm businesses with emphasis on resource allocation, production efficiency, and marginal analysis. Field trips required. *Prerequisite:* 61 or Economics 12; Junior standing; College of Agriculture major. Three hours. Tremblay.

205 Rural Communities in Modern Society. See Sociology 205. Three hours. Schmidt.

207 Markets, Food, and Consumers. Market structure, prices, and economic forces involved in the movement of farm products from producers to consumers. *Prerequisite:* 61 or Economics 12. Three hours. Webster.

208 Agricultural and Food Policy. History and institutional development of agricultural policy. Price and income problems of American agriculture and alternative solutions. *Prerequisite:* 61 or Economics 12. Three hours. Bancroft.

210 Marketing Institutions. Agricultural marketing institutions servicing northeastern U.S. Reading, lectures, and extended field trip. *Prerequisites:* Six hours in agricultural economics and permission of instructor. Three hours. Webster and Tremblay.

218 Community Organization and Development. See Sociology 207. Three hours. Schmidt.

222 Natural Resources Evaluation. An analysis of economic procedures used in the evaluation of public natural resource developments, with emphasis on benefit-cost analysis. *Prerequisite:* 121. Three hours. Gilbert.

225 Economics of Outdoor Recreation and Tourism. A socioeconomic analysis of recreation and tourism as an industry. Emphasis on regional, state, and community impact. *Prerequisite:* 61 or Economics 12. Three hours. Bevins and Gilbert.

233 Rural Planning. Study of rural, regional, water, and natural resource planning concepts and principles. Field exercises in plan evaluation, carrying capacity, agricultural land protection, growth control, etc. *Prerequisites:* Senior standing and 61 or equivalent. Three hours. Sargent.

234 Practicum in Rural Planning. Off-campus planning experience for seniors and graduate students. *Prerequisites:* 233 and consent of instructor. One to six hours credit. Sargent.

235 Legal Aspects of Planning and Zoning. See Natural Resources 235. Three hours.

254 Production Economics. Principles and application of the economics of production in agriculture; emphasis on factor use, enterprise selection and combination, and decisionmaking. *Prerequisites:* 61 or Economics 12, Mathematics 19, or permission of instructor. Three hours. Bancroft.

255, 256 Special Topics in Agricultural and Resource Economics. Readings and discussion of selected topics in economics, including those not encompassed in regular course offerings, at an advanced level. *Prerequisite:* Departmental permission. Credit as arranged.

264 Agricultural Price Analysis and Forecasting. Analysis and measurement of factors affecting supply, demand, and elasticity; their relation to the level and changes of market prices; and use of quantitative techniques in forecasting. *Prerequisites:* 61 or Economics 12, Mathematics 19, or permission of instructor; Computer Science 3 and Statistics 111 helpful. (Not offered Fall 1983.) Three hours. Pelsue.

266 Economics of Managerial Decisions. Applying economic concepts to problems of capital budgeting, tax planning, pricing, demand analysis, and discounting cash flows. Cases. *Prerequisite:* Economics 12 or equivalent. Three hours. Fife.

271 Agriculture in Economic Development. The role of agriculture in development of less developed countries. Discussion of alternative economic development models. Review of various development programs, including Mexico, China, France, Yugoslavia. *Prerequisite:* 61 or Economics 12. Three hours. Sargent.

272 Seminar on World Food Problems and Policies. Review of recent books and periodical literature; discussion and written or oral reports on topics of contemporary interest. *Prerequisite:* 271 or permission. Three hours.

287 Spatial Analysis. See Geography 287. Three hours. Bodman.

322 Advanced Resource Economics. A critical evaluation of contemporary natural resource allocation procedures in the public sector. *Prerequisite:* 222 or equivalent. Three hours. Gilbert.

351 Research Methods. Developing research projects with the scientific method, evaluating alternative literature review, sampling, surveying, analytic methods, and reporting the results. *Prerequisite:* Three hours of statistics. Three hours. Pelsue.

381 Agricultural and Resource Economics Seminar. Discussion problems and research in agricultural and resource economics and regional planning. One hour.

391 Master's Thesis Research. Credit as arranged.

ANATOMY AND NEUROBIOLOGY

Professors Parsons (Chairperson), and Young; Associate Professors Freedman, Kriebel, Krupp, and Wells; Assistant Professors Ariano, Boushey, Cornbrooks, Fiekers, and Kromer; Lecturer Fonda.

Departmental research activities center around investigations on nervous system structure and function and thyroid cytophysiology. Specific areas of interest include: physiology and pharmacology of synaptic transmission, cytochemistry of neurotransmitter and cyclic nucleotide interactions in the basal ganglia, neuronal regeneration and plasticity using intracephalic implants of embryonic tissue into adult CNS, development of monoclonal antibodies to analyze Schwann cell-neuronal interactions in tissue culture, analysis of the avian motor system, the caudal neurosecretory system of fish, neuronal "sprouting" and recovery of function, and cellular dynamics of thyroid follicular cells. Additional opportunities exist for a multidisciplinary program in Neurobiology.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Students are admitted to the Ph.D. program only, not to a M.S. program. Ph.D. students may subsequently complete a M.S. degree with the permission of the department.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of required courses and Research Rotations. Acceptance of a written report and oral presentation on the proposed thesis as approved by the Research and Dissertation Committee.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Thirty credits of courses and research, including Anatomy and Neurobiology 301, 302, 311; comprehensive examination. Additional credits as arranged for laboratory research leading to a dissertation. A grade of B or better must be obtained in any course taken in Anatomy and Neurobiology

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Bachelor's degree; one year of Organic Chemistry/Biochemistry; a year of Advanced Biology; one course in College Physics. Additional courses in Calculus, Differential Equations, Statistics, Computer Science, and Physical Chemistry are recommended. A deficiency in one prerequisite course can be made up in the summer session before entry into the program. A master's degree is not a prerequisite for the Ph.D. degree. Satisfactory scores on the general (aptitude) Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory completion of required courses and Research Rotations. Approval of the written and oral portions of the qualifying comprehensive examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Anatomy 301, 302, 306, 311, 351 or 352, 395 or 396, and 491; Physiology and Biophysics 304, 305; Biochemistry 301, 302. Additional elective courses and teaching assignments as arranged with the department; departmental research rotations; dissertation research; credits as required by the Graduate College. Candidacy examination; successful completion of dissertation. A grade of B or better must be obtained in any course taken in Anatomy and Neurobiology.

COURSES OFFERED

Note: Departmental permission is required for all courses.

201 Human Gross Anatomy. Emphasizes the structure, function and clinical correlations of the musculoskeletal, peripheral nervous, cardiovascular and respiratory systems. Laboratory consists of detailed regional dissections. *Required for Physical Therapy students.* Five hours. Kriebel, Ariano.

202 Neuroanatomy and Histology. Structural basis of human nervous system function, from peripheral nervous system, spinal reflex organization to detailed analysis of motor, sensory systems. Clinical examples. Laboratory. *Required for physical therapy students.* Three hours. Wells.

301 Medical Gross Anatomy. Individualized laboratory instruction, small group conferences, clinically correlated lectures. Basic anatomical information. Emphasis on importance of the relationship between normal human structure and function. Six hours. Krupp, Boushey, Fonda.

302 Neuroscience. A correlated presentation of the neuroanatomy and neurophysiology of the mammalian central nervous system. The course consists of lectures, demonstrations, laboratory, and clinical correlation workshops. Four hours. Freedman, Kromer.

306 Techniques in Neurobiology. Discussion, demonstration of techniques used to study the nervous system. Experience with light, fluorescence, electron microscopy; microsurgical procedures; electrophysiological stimulating, recording techniques; neuronal tracing techniques. *Prerequisite:* Neuroscience 302. Three hours. Fiekers.

311 Medical Histology. The course as presented to medical students. Microscopic study of cells, tissues and organs emphasizing the correlation of structure and function. Three hours. Fiekers, Cornbrooks.

320 Developmental Neurobiology. Embryonic and early postnatal development of selected regions of mammalian CNS. Provides fundamental knowledge of cell-to-cell interactions necessary for proper development, organization of mammalian nervous system. *Prerequisite:* Neuroscience 302 or consent of instructor. Two hours. Kromer. Alternate years.

322 Neuroendocrinology. Consideration of the diencephalic regulation of hormonal activity. The major emphasis will be devoted to morphological features of hypothalamic mechanisms controlling pituitary hormone secretion. *Prerequisite:* Neuroscience 302. Two hours. Kriebel, Freedman. Alternate years.

325 Advanced Neuroanatomy. Morphology of the nervous system. Lectures and laboratory. Regional approach to anatomy. Units on development, blood supply, autonomic nervous system. Laboratory: brain dissection, microscopic examination (brain stem). *Prerequisite:* Neuroscience 302. Three hours. Kromer. Alternate years.

342 Special Dissections in Gross Anatomy. This course provides for a detailed and independent study of a single anatomical region, utilizing gross, microscopic and embryologic materials. *Prerequisite:* Anatomy and Neurobiology 301. Credit as arranged. Krupp, Boushey, Fonda.

351, 352 Techniques in Electron Microscopy. Techniques to produce electron micrographs of biological specimens. Operation of conventional transmission electron microscopes, specimen preparation, interpretation of micrographs. Lecture/demonstration of scanning electron

microscopy. Credit as arranged. Kriebel.

381, 382 Seminar in Anatomy and Neurobiology. Research presentations and critical review of the literature in various areas of anatomical and neurobiological sciences. One hour.

391 Master's Thesis Research. Credit as arranged.

395, 396 Special Topics in Neuroscience. A supplementary course to the medical neuroscience course (Neuroscience 302) designed for graduate students which will provide more detailed information concerning selected topics in neurobiology. *Prerequisite:* Neuroscience 302. Two hours. Parsons.

491 Doctoral Dissertation Research. Credit as arranged.

ANIMAL SCIENCES

Professors Atherton, Balch, Bolton, Bull (Chairperson), Carew, Duthie, Foss, Smith, and Welch; Associate Professors Kunkel, Murray, Simmons; Assistant Professors Gilmore, Ryan; Extension Professors Gibson, Wadsworth; Extension Assistant Professors Saenger, Wildman.

Research activities in basic and applied science encompass a broad range of interests. The areas of study and research include genetics; nutrition; physiology; virology; diseases of cattle affecting reproduction; parasitism; dairy plant management, chemistry, or microbiology; quality control aspects of the food industry.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An acceptable undergraduate major in the Animal Sciences, Chemistry, Biology, or a related field. Satisfactory scores on the general (aptitude) Graduate Record Examination must be presented. In certain of the Animal Health areas, a degree of Doctor of Veterinary Medicine may be helpful.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

The applicant must satisfy the requirements of the Graduate College and pass the general qualifying examination administered by the Department of Animal Sciences.

MINIMUM DEGREE REQUIREMENTS

Fifteen-21 hours in Animal Sciences and one of several related fields; thesis research (nine-15 hours).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory scores on the general (aptitude) Graduate Record Examination must be presented.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The applicant must satisfy the prerequisites of the Graduate College and pass the

general qualifying examination administered by the Department of Animal Sciences.

MINIMUM DEGREE REQUIREMENTS

The Department of Animal Sciences believes each graduate program has its individual needs and must be arranged accordingly. The candidate must meet all the requirements as prescribed by the Graduate College for the degree of Doctor of Philosophy. In addition, all courses and seminars as established by the Studies Committee must be satisfactorily met, doctoral research must be completed, and an acceptable dissertation written and defended. In accord with the policy of the Animal Sciences Department, all doctoral students will be provided the opportunity to participate in the department's undergraduate teaching program. Proficiency in a modern foreign language or computer language and programming is optional at the discretion of the Studies Committee.

COURSES OFFERED

201 Fermented Dairy Foods. Fundamental processes in the manufacture of economically important cheese varieties and other cultured dairy foods. Acquired knowledge of manufacturing procedures applied at the pilot plant level. *Prerequisites:* 3; Junior standing. Four hours. Ryan.

202 Dairy Industry Managerial Training. Select topics dealing with the organization and management of modern dairy foods processing plants. *Prerequisites:* 101, 102, 103, 104, 201. Three hours. Ryan.

212 Animal Breeding. Principles of quantitative and statistical genetics studied in relation to animal breeding. Methods of selection and schemes of mating discussed. *Prerequisites:* An introductory course in genetics, STAT 141 or instructor permission. Four hours. Gilmore.

213, 214 Dairy Herd Management. Organization and operation of dairy enterprises. Theories and methods of application of feeding, breeding and management programs and principles. *Prerequisites:* 110; Junior standing. Three hours. Gibson, Bull.

215 Physiology of Reproduction and Lactation. Fundamental principles of the physiology of reproduction and lactation with the primary emphasis on farm animals. Three hours. Simmons.

216 Endocrinology. Anatomy, physiology, glandular interrelationships, and assay methods of the endocrine glands and their hormones. *Prerequisite:* Departmental permission. Four hours. Simmons.

242 Advanced Nutrition. (See Human Nutrition and Foods 242.) Three hours. Tyzbir.

245 Nutritional Biochemistry. (See Human Nutrition and Foods 245.) Three hours. Tyzbir.

249 Nutrition Seminar. (See Human Nutrition and Foods 249.) Two hours. Tyzbir.

281 Animal Sciences Senior Seminar. Reports and discussions of problems and special investigations in selected fields. One hour. Foss, Simmons.

282 Animal Sciences Graduate Seminar. Reports and discussions of problems and special investigations in selected fields. One to three hours. Foss.

294 History of Nutrition. (See Human Nutrition and Foods 294.) One hour.

297, 298 Special Problems in Animal Sciences. Reading, discussion, and special laboratory investigation in the field of animal sciences. *Prerequisite:* Departmental permission. May enroll more than once for maximum of six hours.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

ANTHROPOLOGY (See Page 175)

ART (See Page 175)

BIOCHEMISTRY

Professors Lamden, Meyer, J. Thanassi (Acting Chairperson), and Woodworth; Associate Professors Auletta, Chiu, Cutroneo, and Hart; Research Associate Professor Ehrlich; Research Assistant Professors Little, N. Thanassi.

Current research programs include studies of mechanisms controling ovarian function (F. Auletta); nuclear protein chemistry (J.-F. Chiu); the effects of anti-inflammatory steroids on proline metabolism and collagen synthesis (K.R. Cutroneo); neurochemistry of receptor function and molecular mechanisms of neuronal plasticity (Y. H. Ehrlich); the toxicity of cadmium and its reactions in biological systems (B.A. Hart); nutritional biochemistry; vitamins A, C, E and lipid peroxidation (M.P. Lamden); mammalian RNA and ribonucleases and their metabolic regulation and relation to neuromuscular disease (B. Little);regulatory mechanisms for protein and nucleic acid processing and breakdown in muscle (W.L. Meyer); chemistry and biochemistry of vitamin B_6 (J.W. Thanassi); and the nature of the binding of metals to proteins, particularly the ironbinding proteins of blood plasma (R.C. Woodworth).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE OR FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory score on the Graduate Record Examination (GRE) including the subject (advanced) portion of GRE. In addition:

Year courses in organic chemistry, physical chemistry, and physics (equivalent to Chemistry 141, 142 or 143, 144, Chemistry 162 and Physics 15, 16); quantitative chemistry; mathematics through differential and integral calculus; a year course in a biological science.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE OR FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

Under most circumstances, meeting the requirements for admission as stated above will allow advancement to either degree program.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Thirty credit hours, 16 of which must be taken from graduate courses offered by the Department of Biochemistry, including Biochemistry 301, 302, 303, 381, and 391 or 392.

Thesis Option

Up to 14 credit hours of Master's Thesis Research (Biochemistry 391.)

Non-thesis Option

Up to eight credit hours of Independent Literature Research (Biochemistry 392.)

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

A total of 75 hours, including 20 hours from graduate courses offered by the Department of Biochemistry including Biochemistry 301, 302 or 305-306, 303 and participation throughout residence in Biochemistry Seminars; three hours from graduate courses offered by the Department of Chemistry; 10 additional hours from courses in physical or biological sciences; 30 hours of Doctoral Dissertation Research.

COURSES OFFERED

Biochemistry 211-212, 301-302, 303, 305-306, and 381 are offered annually. Advanced courses are given in alternate years.

211-212 Biochemistry for Health Sciences. For medical technology students. Comprehensive study of mammalian biochemistry, particularly human. Laboratories include medically-oriented experiments utilizing modern clinical chemistry techniques. Case studies from MCHV correlate lecture, laboratory. *Prerequisites:* 102 or quantitative chemistry; organic chemistry. Physiology is strongly recommended. Four hours per semester. Hart.

301-302 General Biochemistry. Survey for science majors. Topics: chemistry, structure, metabolism, and function of proteins, amino acids, carbohydrates, lipids, nucleic acids; enzymes; bioenergetics; respiratory processes; cellular and physiological control mechanisms. *Prerequisites:* Chemistry 141, 142 or 143, 144 and departmental permission. Three hours per semester. J. Thanassi, Coordinator.

303 Biochemistry Laboratory. Experimental work designed to demonstrate important principles and to illustrate methods and techniques of modern biochemistry. *Prerequisites:* 301, 302 or 305-306, or concurrent registration therein, and departmental permission. One to four hours. W. Meyer, Coordinator.

305-306 Medical Biochemistry. For medical students. Survey of human physiological, molecular biochemistry; chemistry, metabolism of cellular and dietary constituents; enzymes and bioenergetics; blood, respiration, acid-base balance, mineral metabolism; metabolic controls. *Prerequisites:* Chemistry 141, 142 or 143, 144 and departmental permission. Given on a trimester basis in the College of Medicine calendar; equivalent to three hours per semester for two semesters. Staff.

307, 308 Special Topics in Biochemistry. Areas of biochemistry not treated in concurrent advanced course offerings. Topics include: intermediary metabolism, organic and physical biochemistry, enzymology, physiological chemistry. Two areas are usually covered each semester. *Prerequisites:* 301, 302 or 305-306; Chemistry 162. Two hours per semester. Staff.

320 General Enzymology. General consideration of enzyme nomenclature, purification, assay, introductory kinetics, mechanisms, cofactors, active sites, subunit structure, allosteric and regulatory properties, and control of multienzyme systems. *Prerequisites:* 301, 302 or 305-306; Chemistry 162. Three hours. Meyer.

331 Nucleic Acids. The structure, organization, function, and metabolism of nucleic acids. *Prerequisites:* 301-302 and 305-306. Two hours. Cutroneo and staff.

340 Bioorganic Chemistry. Organic reaction mechanisms as related to substances or biochemical interest, with emphasis on catalytic mechanisms. *Prerequisites:* 301, 302 or 305-306. Two hours. Thanassi.

350 Biochemistry of Cell Differentiation. Biochemical basis, molecular mechanism of cell differentiation, neoplastic transformation. Specific models on cell differentiation and approaches to understanding cell dif-

ferentiation, (i.e., gene cloning and DNA-mediated cell transformation). *Prerequisites:* 301-302 or 305-306. Three hours. Chiu.

367 Biochemical Endocrinology. Studies of biochemical mechanisms of hormonal recognition, interaction, with eukaryotic cells. Topics: detailed analysis, comparison of metabolic action, mechanisms of gene activation by hormones. *Prerequisites:* 301, 302 or permission. Three hours. Staff.

371 Physical Biochemistry. Protein interaction, solubility and fractionation, electrophoresis, sedimentation, phase rule study, diffusion, viscosity, spectrophotometry, and related topics. *Prerequisites:* 301, 302 or 306; Chemistry 160 or 162. Three hours. Woodworth.

375 Cancer Biology. Overview of cancer biology for Health Science students. Foundation for cancer research. Lecture format; interdisciplinary viewpoint; outside lecturers. *Prerequisites:* 301-302 or 305-306; under special circumstances, 211-212. Three hours per semester.

381 Seminar. A review of recent developments and current literature in the various fields of biochemistry. *Prerequisite:* Departmental permission. One hour per semester.

391 Master's Thesis Research. Credit as arranged.

392 Independent Literature Research. Reading and literature research culminating in a paper on a topic of current interest in biochemistry. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

BIOMEDICAL ENGINEERING

A cooperative program offered by the Department of Computer Science and Electrical Engineering (F.C. Evering, chairman), the Department of Civil Engineering and Mechanical Engineering (C. Hermance, chairman), and the Department of Physiology and Biophysics (N.R. Alpert, chairman).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An accredited bachelor's degree in an appropriate field.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited bachelor's degree in Electrical or Mechanical Engineering or equivalent. Courses in biology and chemistry may be recommended as prerequisites. Applicants with backgrounds other than Electrical or Mechanical Engineering will generally be required to make up undergraduate deficiencies.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 301; 12 hours in Electrical or Mechanical Engineering, Physics and Mathematics; additional approved courses; thesis research (six-12 hours) in the Department of Electrical or Mechanical Engineering. Each applicant should consult the department to determine if the program offered meets his/her specific educational objectives.

Biomedical engineering is one of the areas of research interest in the graduate programs in Electrical and Mechanical Engineering.

BIOSTATISTICS

This program is administered through the Statistics Program. Dr. D.L. Sylwester is the program director.

The Program offers a concentration in biostatistics leading to the M.S. Degree. The Curriculum takes full advantage of statistics courses taught in the Statistics Program and includes experience in a variety of health, biomedical, and related research projects at the University of Vermont. The curriculum is designed to give trainees maximal opportunity to use their academic training and work experience to assist in defining problems, formulating rational methods of inquiry, and gathering, analyzing, and interpreting data as they relate to the specific problem under investigation.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES AND ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major which provides a foundation for the application of statistical methodology and concepts to health and biomedical problems. It is anticipated that candidates will have completed three semesters of calculus including matrix algebra methods. However, provisional admission to the program can be given prior to the completion of these requirements. Computer experience would be desirable. The Graduate Record Examination is strongly advised and is required of any applicant who wishes to be considered for a teaching fellowship.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Plan A: Twenty-four semester hours of course work. This will include Biostatistics 200, 201, 211, 221, 223, 224, 241, 383, 384 and six hours of approved thesis work.

Plan B: Thirty semester hours of course work. This will include Biostatistics 200, 201, 211, 221, 223, 224, 231, 241, 383, 384.

All students are expected to participate in the projects of the Biometry Facility and to attend the regular colloquium series as part of their training. During the latter part of his training the student will be expected to take major responsibility for some project, including the presentation of the final report for this project.

COURSES OFFERED

201 Statistical Analysis via Computer. See Statistics 201.

202 Population Dynamics. See Sociology 202.

211,221 Statistical Methods I, II. See Statistics 211, 221.

223,224 Statistical Methods III, IV. See Statistics 223, 224.

231 Experimental Design. See Statistics 231.

241 Introduction to Statistical Inference. See Statistics 241.

254 Sociology of Health and Medicine. See Sociology 254.

261,262 Statistical Theory I, II. See Statistics 261, 262.

381 Biometry Practicum. See Statistics 281.

383,384 Seminar I, II. See Statistics 383, 384.

385 Consulting Practicum. See Statistics 385.

391 Master's Thesis Research. Credit as arranged.

BOTANY

Professors Etherton, Hyde, Klein, Vogelmann (Chairperson) and Worley; Associate Professors Barrington, Cook, and Ullrich; Research Associate Professors Laing and Morselli; Research Assistant Professor Lintilhac.

The Botany Department has ongoing research programs in: ecology including plant communities, biogeography, limnology, phycology, bryology, and pteridology; physiology including growth and development, mineral nutrition, translocation, tissue culture, photobiology, cellular electrophysiology, and membrane function; and cell biology including ultrastructure of cytoplasm and nucleus, and genetics of fungi. The Botany Department offers a multidisciplinary program leading to the degree Master of Science in Botany Field Naturalist Option. This is a non-thesis concentration and enrollment is limited to a small number of highly qualified students with strong academic backgrounds in basic natural sciences. Students must have demonstrable and sustained interest in the field aspects of the natural sciences. The program is designed to train general field scientists to identify, evaluate, and interpret the biotic and abiotic components of different ecosystems with a comprehensive perspective. The Botany Department also participates actively in the Cell Biology Program which provides opportunities for interdisciplinary research with other life science departments.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Six semester courses in botany; supporting courses in other sciences and in mathematics. Satisfactory scores on the general (aptitude) and subject (advanced) sections of the Graduate Record Examination.

MINIMUM DEGREE REQUIREMENTS

Fifteen-21 hours in botany and closely related fields; thesis research (nine-15 hours). Each candidate must participate in the teaching of at least one undergraduate course.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE FIELD NATURALIST OPTION

A baccalaureate degree in a natural science area such as botany, zoology, or geology with a strong course background in field related subjects, especially botany (systematics, soils, ecology, etc.); a demonstrated commitment and involvement in field sciences (participation in scientific, environmental, and con-

servation organizations, workshops, field trips, research, publications, etc.); satisfactory scores on the Graduate Record Examination including the subject (advanced) test in biology.

MINIMUM DEGREE REQUIREMENTS

Thirty-six to 60 credit hours of courses to include at least two courses in each of three core areas: (1) biota, (2) earth science, (3) ecology, the number of credits and the course selection to be determined by the student's studies committee. Enrollment in a field naturalist practicum each semester. A written and oral compre hensive examination to be completed during the third semester. A written field analysis project at the termination of the formal course of study.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS IN TEACHING

The department offers a program leading to the degree of Master of Arts in Teaching: see page 49. Satisfactory scores on the Graduate Record Examination general (aptitude) section are requirements for acceptance for this degree.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS (BIOLOGY)

A bachelor's degree from an accredited institution and certification as a teacher of biology or an associated field. At least three years of secondary school teaching. Satisfactory scores on the Graduate Record Examination general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS FOR THE M.S.T. (BIOLOGY)

Thirty hours of course work to include a selection of courses in the Departments of Botany and Zoology which will broaden and balance the undergraduate work in biology. At least two 200 level courses in each department. Courses in four of the five following areas: anatomy; morphology and systematics; genetics; developmental biology; and environmental biology. Up to 12 hours of 100 level courses may be used for the above requirement where approved by the advisor and the Dean. Appropriate courses in related science departments may be used to complete the required 30 hours. No thesis is required; however, each degree recipient must complete a written and oral examination.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES 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 of organic chemistry comparable to Chemistry 141, 142; two semesters of calculus comparable to Mathematics 21, 22 and in some cases a third semester of calculus comparable to Mathematics 121; a year of physics comparable to Physics 15, 16. Satisfactory scores on the Graduate Record Examination general (aptitude) and subject (advanced) sections..

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Completion of one academic year, but not more than two years, in graduate study at the University of Vermont. The specific language requirement for the candidate is to demonstrate ability to comprehend the contents of articles in the biological sciences in a modern foreign language appropriate to the student specialty and approved by the Studies Committee.

MINIMUM DEGREE REQUIREMENTS

The candidate is required to accumulate a minimum of 75 credits from course work and dissertation 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 six semester contact hours is also requisite.

COURSES OFFERED

205 Mineral Nutrition of Plants. Role of essential elements for plant growth including classical and modern approaches to the study of ion availability and transport. *Prerequisite:* 104. Three hours. Etherton. Alternate years, 1984-85.

209 Biology of Ferns. Evolutionary biology; a survey of New England ferns and their phylogenetic relationships; current research emphasizing morphological, biogeographical, genetic and phytochemical aspects of speciation. *Prerequisites;* 108; 101 recommended. Three hours. Barrington. Alternate years, 1983-84.

213 Plant Communities. Plant sociology; structure and organization of the plant community; sampling methods and analysis of data; climatic and edaphic factors; field work. *Prerequisite:* 109 or departmental permission. Three hours. Vogelmann.

229 Water Relations of Plants. See Forestry 229.

232 Botany Field Trip. Trips to selected environments outside Vermont. Led by several faculty members representing different fields of Botany. Overall, integrated approach to ecology, structure, and function. One hour. Christmas or spring vacation or end of school year.

234 Ecology of Freshwater Algae. Environmental factors influencing distribution and seasonal succession; quantitative methods for estimating standing crop productivity; kinetics of algal growth; competitive and synergistic interactions. *Prerequisite:* 160 or Biology 102. Three hours. Cook. Alternate years, 1983-84.

241 Tropical Plant Systematics. Diversity of tropical flowering plant communities; recent systematic, evolutionary angiosperm research; anatomy, morphology, ecology, geography of major families. Student presentations on an aspect of recent research. *Prerequisite:* 109. Three hours. Barrington. Alternate years, 1984-85.

250 Microtechnique. Theory and practice in the preparation of biological materials for anatomical and cytological study, including histochemistry and photomicrography. *Prerequisites:* Introductory chemistry; some knowledge of organic chemistry, anatomy, or cytology is desirable. Three hours. Cook. Alternate years, 1983-84.

252 Molecular Genetics II: Regulation of Gene Expression in Eukaryotes. Processing of information present in nucleic acids; knowledge generated from recombinant DNA techniques applied to higher cells; control in transposition, transformation, transcription, and processing transcript. *Prerequisites:* Biology 101 or Biochemistry 301, or equivalents; Medical Microbiology 211 preferred; permission of the instuctor. Three hours. Ullrich.

255 Structure and Function of Chromosomes. Analysis of recombination in eukaryotes. Arrangement of DNA, proteins. DNA duplication, mapping of certain DNA regions. Molecular nature of meiotic

processes, control of gene expression (reference to nucleolus). *Prerequisites:* 101; Chemistry 42 or 141, 142. Three hours. Hyde.

257 Physiology of the Plant Cell. Detailed study of photosynthesis, plant cell membrane function, and plant cell growth. *Prerequisites:* 104; Chemistry 141, 142 or Chemistry 42; Physics 11, 12 or 15, 16; Four hours. Etherton. Alternate years, 1983-84.

281 Botany Seminar. Presentations of personal research by faculty, graduate students, and outside guest speakers. Attendance required of botany graduate students and seniors in botanical research programs. Without credit.

295 Special Topics. For advanced students within areas of expertise of faculty and staff. Aspects of ecology, physiology, genetics, cytology, bryology, pteridology, paleobotany, photobiology, membrane physiology, cell biology. *Prerequisite:* Permission of instructor. Credit as arranged.

301 Cell Biology. Advanced survey of cell organelles, their composition, origin and the relationship between their structure and function. Stress will be placed on recent literature and current controversies. *Prerequisites:* Chemistry 142, graduate standing in biology or permission of instructor. Three hours. Hyde.

311 Field Naturalist Practicum. Readings and analysis of field studies and writings of contemporary and classical naturalists; planning and designing field project. *Prerequisites:* Enrollment in the Field Naturalist program. Three hours. Worley.

381 Selected Problems in Modern Botany. Subject matter varies but will stress recent botanical inquiries, particularly where they border on mathematics, physics, and chemistry. *Prerequisite:* Departmental permission. One to three hours credit.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

BUSINESS ADMINISTRATION

Professors Grinnell, Laber, Severance and Thimm (Director); Associate Professors Gatti, Kraushaar, Michael, Shirland, and Tashman; Assistant Professors Battelle, Cats-Baril, Gurdon, and Parke.

BUSINESS ADMINISTRATION

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES AND FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION

The MBA program consists of three Tiers of courses. Tier I must be completed successfully before a student is admitted to candidacy for the degree. Students will be admitted to the Graduate College before Tier I is completed, and enrollment in Tier II courses is restricted to students who have applied for admission to the Graduate College.

In addition to transcripts of prior undergraduate and graduate training, the applicant is required to submit scores on the Graduate Management Admissions Test. (GMAT scores are accepted in lieu of Graduate Record Examination scores for financial assistance in this program.)

MINIMUM DEGREE REQUIREMENTS

Students must complete all of the courses listed in Tiers I, II, and III. Tier I must be completed before enrollment in any Tier II courses.

TIER I

(UVM course equivalents listed)

Principles of Economics, 6 hours	(Economics 11, 12)
Calculus, 3 hours	(Math 19)
Computer Programming	(Computer Science 11)

TIER II

BSAD 304	Managerial Economics	1.5 hours
BSAD 305	Fund. of Marketing Management	1.5 hours
BSAD 306	Financial Accounting	3.0 hours
BSAD 307	Fund. of Organizational Behavior	1.5 hours
BSAD 308	Corporate Finance	3.0 hours
BSAD 309	Fund. of Legal Environment of Business	1.5 hours
BSAD 313	Statistical Analysis for Management	3.0 hours
		15 hours

Normally, Tier II will be completed before enrollment in Tier III courses. Tier II courses may be waived by qualifying examinations in the event of previous academic or work experience. All students will complete BSAD 306 and BSAD 313 during their first semester in the program.

TIER III

BSAD 340	Quantitative Methods and Production Models	3 hours
BSAD 345	Management Information Systems	3 hours
BSAD 359	Marketing Management	3 hours
BSAD 365	Management Accounting	3 hours
BSAD 375	Organizational Theory	3 hours
BSAD 380	Managerial Finance	3 hours
BSAD 396	Business Policy	3 hours
Electives from 300-level courses		9 hours
		30 hours

A minimum of 30 hours of 300-level credit must be completed at UVM for the MBA degree.

COURSES OFFERED

304 Managerial Economics. An introduction to the application of economic analysis to managerial decisions. Topics include marginal analysis, demand estimation, cost and production functions, and optimization. *Prerequisites:* BSAD 313, MBA standing. One and one-half hours.

305 Fundamentals of Marketing Management. Accelerated course on marketing principles and theory. Analytical approach to study of product pricing strategies; distribution, communication, and promotion; consumer behavior and development of corporate marketing strategy. *Prerequisite:* MBA standing. One and one-half hours.

306 Financial Accounting. Introduction to basic concepts, assumptions, conven-

tions providing foundation for developing financial statements. Analysis, interpretation of the income statement, balance sheet, statement of changes in financial position. *Prerequisite:* MBA standing. Three hours. Battelle/Grinnell.

307 Fundamentals of Management and Organizational Behavior. Accelerated study of individual, group behavior in organizational settings. A managerial perspective to examine theories of motivation, perception, communication, group dynamics, leadership, organization design, organization development. *Prerequisite:* MBA standing. One and one-half hours. Gurdon/Parke.

308 Corporate Finance. An introduction to financial decision making in the firm. Decisions related to acquisition and allocation of funds are examined, and practiced through cases and problems. *Prerequisites:* BSAD 306, MBA standing. Three hours. Gatti/Laber

309 Fundamentals of Legal Environment of Business. General overview of areas of interaction between businesses and governments. Examination of governmental policy toward business and review of laws governing business-government interactions. *Prerequisite:* MBA standing. One and one-half hours.

313 Statistical Analysis for Management. Data analysis and communication of statistical information for managerial decision making. Methods of modeling relationships, comparing strategies, and assessing probabilities. Instruction in computer use. *Prerequisite:* MBA standing. Three hours. Tashman.

340 Quantitative Methods and Production Models. Models for the design and control of production and service processes. Linear programming, production scheduling and inventory control, network models, queuing, selected mathematical programming techniques. *Prerequisite:* MBA standing. Three hours. Shirland.

341 Regression, Time Series, and Forecasting. Application of regression analysis and of modern time-series techniques to managerial decision-making and forecasting. Case method approach. Instruction in use of computer programs included. *Prerequisite:* MBA standing. Three hours. Tashman.

345 Management Information Systems. An introduction to the design and implementation of management information systems. A theoretical framework is developed and applied by students to an information system. *Prerequisite:* MBA standing. 3 hours. Kraushaar.

359 Marketing Policy. Concepts from quantitative methods, economics, behavioral sciences applied to marketing management. Includes: marketing opportunities, organizing for marketing, planning marketing programs, control of marketing effort. Case book method. *Prerequisite:* MBA standing. Three hours.

360 Contemporary Financial Accounting and Reporting. Current financial accounting, reporting practices; focus on contemporary issues, problems. Impact of pronouncements of Accounting Principles Board, Financial Accounting Standards Board, Securities and Exhange Commission, and other bodies. *Prerequisite:* MBA standing. Three hours. Grinnell.

365 Management Accounting. Study of development, utilization of accounting information for product costing and pricing purposes, for routine planning and control of organizational activities, for decision-making purposes. *Prerequisite:* MBA standing. Three hours. Grinnell.

371 Personnel Administration. Critical examination of contemporary problems, controversies in personnel administration. Current issues, topics (affirmative action, discrimination in employment) covered with more traditional topics of wage and salary administration, etc. *Prerequisite:* MBA standing. Three hours. Parke.

375 Organization Theory. Organization theories examined for insights into behaviors of organizations and their members. Open systems perspective. Indentification of contingencies in organization design based on human, structural, technological, environmental variables. *Prerequisite:* MBA standing. Three hours. Parke.

376 The Management of Change In Organizations. Applied behavioral science perspective adopted to identify conceptual issues, develop diagnostic skills, examine alternative intervention strategies relevant to accomplishment of planned changes in organizational systems. *Prerequisite:* MBA standing. Three hours.

379 Strategic Management. Case studies

of existing organizations are used to illustrate the intellectual, social processes of adaptation to a changing environment; strategy formulation, implementation. Not offered every year. *Prerequisite:* MBA standing. Three hours. Arns.

380 Managerial Finance. Focus on key financial decisions that affect the value of the firm. Topics: capital structure, leasing, mergers and acquisitions, capital market theories and evidence. *Prerequisite:* MBA standing. Three hours. Laber.

382 Investment and Portfolio Analysis. Examination of the investment decision process. Specific topics include operations of equity securities markets, market efficiency, capital asset pricing model, and portfolio management. *Prerequisites:* 308, MBA standing. Three hours. Gatti.

384 Financial Markets and Interest Rates. Study of level and structure of interest rates. Topics: flow of funds accounting, market vs. natural rate of interest, interest rate structure, behavior of interest rates over business cycle. *Prerequisite:* MBA standing. Three hours. Gatti.

394 Independent Readings & Research. This course is intended to allow a student to pursue independent research under the direction of a faculty member. Normally, the course will include a research paper. *Prerequisite:* Permission of the Graduate Studies Committee. One to three hours.

395 Special Topics. This course will include topics and material that may develop later into a regular course offering; in addition, it may include topics and material offered only once. *Prerequisite:* Permission of the Graduate Studies Committee. One to three hours.

396 Business Policy. A case course focusing on the resolution of complex cases involving simultaneous solutions of problems in two or more functional areas. *Prerequisite:* MBA standing; 21 hours of graduate credit. Three hours. Staff.

CELL BIOLOGY (Interdisciplinary)

Participating faculty are from the following departments: Anatomy and Neurobiology; Botany; Biochemistry; Medical Microbiology; Medicine; Microbiology and Biochemistry; Pathology; Pharmacology; Physics; Physiology and Biophysics; Zoology.

An interdisciplinary program leading to M.S. and Ph.D. degrees in Cell Biology is offered under the direction of a committee composed of faculty members drawn from the participating departments. The program provides the flexibility necessary for a student to gain competence in the area of his/her choice. The extensive research facilities of the participating departments are available to all graduate students enrolled in the program. Inquiries should be directed to the Cell Biology Program Chairman, William L. Meyer, Department of Biochemistry.

Research includes: (Absher) cellular aging and cellular mechanisms of pulmonary fibrosis; (Adler) role of contractile proteins in secretion and nonmuscle cells; (Albertini) human somatic cell genetic mutations, histocompatability genetics; (Ariano) cytochemistry of neurotransmitter and cyclic nucleotide interactions in the basal ganglia; (Chiu) regulation of gene activities in developing and neoplastic tissues; (Craighead) pulmonary disease viral infections, carcinogenesis; (Currier) chemotaxis and root nodulation; (Cutroneo) regulation of collagen synthesis; (Evans) airway and pulmonary vascular smooth muscle; (Happ) hormonal control of differentiation in insects; (Hart) metal toxicity in the lung; (Huber) immunopathology; (Hyde) plant cytogenetics, nuclear ultrastructure; (Johnstone) biochemistry and physiology of *Azotobacter* and *Azomonas;* (Kelleher) control of protein synthesis in mammalian cells, oncodevelopmental gene products; (Kelley) connective tissue proteins and *in vitro* models of disease; (Kilpatrick) electrophoretic and chromosomal analysis of

populations; (Krupp) dynamics of thyroid follicular cells; (Landesman) gene control and the role of morphogenic information during amphibian limb development; (Low) protein metabolism in eukaryotic systems; (Meyer) physiological control of neutral proteases, ribonucleases and esterases, relationships to muscle disease, development, tumor biology, interferon and resistance to infection; (Moehring) cell culture; mechanisms of pathogenesis of toxins; biochemical genetics; and cytogenetics; (Morselli) tissue and organ culture studies on growth and differentiation of woody plants; chemistry and microbiology of maple sap, wood and bark; (Mossman) carcinogenesis of tracheo-bronchial tree; (Newman) pharmacology and toxicology of cancer chemotheraputic drugs; (Novotny) isolation and expression of genes in the mushroom *Schizophyllum;* (Nyborg) biophysics of ultrasound; (Pennypacker) influence of extracellular matrix on cell behavior; (Racusen) biochemistry of plant proteins; (Schaeffer) transformation of normal rat liver cell cultures to the tumorigenic state using the carcinogen aflatoxin B1; (Smith) physicochemistry and metabolism of oncodevelopmental proteins; (Ullrich) regulation of gene expression and cellular differentiation in eukaryotes; (VanHouten) genetic analysis of the behavior and physiology of chemoreception in paramecium; (Weller) structure and function of ribosomes and ribonucleases; (Woodworth) biochemistry of iron-binding and transport proteins and cellular iron metabolism.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE AND FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Biology (three semesters, including Genetics), Chemistry through Organic, Mathematics through Calculus, Physics (two semesters). Satisfactory scores on general (aptitude) Graduate Record Examination. Students who do not have all of the courses listed but who have a good academic record will be considered for admission to the program. Deficiencies may be made up after matriculation.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Completion of any deficient admission requirements.

MINIMUM REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Thirty hours of graduate level credit including Cell Biology 301 and one course in each of the three following areas: genetics, biochemistry (one year), and cell physiology; cell biology seminar each semester; thesis research.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Minimum of one semester of Physical Chemistry, equivalent to Chemistry 160. Completion of any deficient admission requirements.

MINIMUM REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Cell Biology 301, one course in each of the three following areas: genetics, biochemistry (one year), and cell physiology; a minimum of 20 additional hours of course work. Studies Committee will advise course selection. Dissertation research, minimum 20 credits. Regular participation in seminar program.

COURSES OFFERED

252 MOLECULAR GENETICS II See Botany 252.

295 SPECIAL TOPICS Credit as arranged.

301 CELL BIOLOGY See Botany 301.

381 SEMINAR One hour. Staff.

391 MASTER'S THESIS RESEARCH Credit as arranged.

491 DOCTORAL DISSERTATION RESEARCH Credit as arranged.

CHEMISTRY

Professors Allen, Bushweller (Chairperson), Flanagan, Geiger, Krapcho, Kuehne, Strauss, White, and Wulff; Associate Professor Weltin; Assistant Professors Carrano, Goldberg and Leenstra.

Current research in organic chemistry includes dynamic NMR studies of intramolecular stereodynamics, syntheses of medicinally valuable natural products, isolation and structure determination of natural products, studies of the stereochemistry of C-alkylation of α-anions, decarboxylation of geminal diesters, biomimetic syntheses, preparation of benzomorphans and their analogues which have chemotherapeutic potential, and mechanistic studies of organic chemical reactions.

Physical chemistry research projects include hydrogen absorption by metals, alloys and intermetallic compounds with a view toward storage of hydrogen as a fuel, theoretical studies of the electronic structure of chemical bonds in small molecules using *ab initio* variation calculations, chemical thermodynamics, statistical mechanical modeling of chemical systems, and optically detected magnetic resonance studies of porphyrins and related compounds.

Research in inorganic chemistry includes investigations of the syntheses, structure, and spectroscopic properties of main-group ring systems and polymers with an emphasis on phosphazenes and sulfur nitrides, electrochemical control of the structure and reactivity of transition metal complexes, studies of the roles of metal ions in the modification and/or control of properties of proteins and other biologically important molecules, and dynamic NMR studies of the stereodynamics of various metal-phosphine complexes.

Research in analytical chemistry includes electrochemical studies of transition metal complexes and organometallic complexes, electron spin resonance studies of materials in unusual oxidation states, novel reactions of reactive compounds generated electrochemically under high vacuum, studies of factors influencing heterogeneous electron transfer processes in non-aqueous media, studies of transient, imploding plasmas as solid sample atomizers for atomic spectroscopy, and the development of instrumentation and techniques suitable for the direct

localized and bulk trace elemental analysis of non-conducting solid samples via atomic spectrometry.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS (PHYSICAL SCIENCES)

An undergraduate major in an appropriate field. Satisfactory scores on the general (aptitude) Graduate Record Examination. Completion of at least one full year of teaching.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS (PHYSICAL SCIENCES)

Successful completion of Physics 128, Chemistry 141 and 162, and Mathematics 121, or their equivalents. (These courses may have been taken at the undergraduate level, as part of this graduate program, or credit may be obtained by transfer or examination.)

A program is also offered leading to the degree of Master of Arts in Teaching. See p. 49.

MINIMUM REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS (PHYSICAL SCIENCES)

The above prerequisites for admission to candidacy must be supplemented by: (1) Completion of 30 hours of credit, of which at least 18 must be in Physical Sciences Option (A) or (B) as described below. The remaining 12 credits may be chosen, with the consent of the Joint Advisory Committee, from appropriate courses above 100 in science, engineering, mathematics, and education (credit in education courses is limited to six semester hours); (2) Successful completion of a comprehensive examination administered by the Joint Advisory Committee.

Physical Sciences Option (A): Nine semester hours of Physics numbered 128 and above, Chemistry 231 and six semester hours of Chemistry chosen from Chemistry 163, 232, 201, 264 and 241. This option is primarily for teachers of chemistry.

Physical Sciences Option (B): Nine semester hours of Chemistry numbered 141 and above and nine hours of Physics in courses numbered above 200. This option is primarily for teachers of Physics.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in an appropriate field. Satisfactory scores on the Graduate Record Examination general (aptitude) section for those requesting financial assistance.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

The requirements for admission to candidacy for the Master of Science degree

are: (1) proficiency in four areas of chemistry evidenced by the biannual qualifying examinations or completion of designated courses at this university; (2) one semester of residence; (3) at least 15 hours of formal course work including (a) six hours of graduate-level courses in the chemical field of specialization, (b) three hours of graduate-level chemistry courses not in the area of concentration, (c) Chemistry 386 (only for those electing Plan A), (d) Chemistry 381 (Seminar), and (e) Chemistry 231; and (4) maintenance of an overall point-hour ratio of 3.00. Students studying in the Master of Science degree program are advised to take the cumulative examinations in their specialty.

MINIMUM REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

The above prerequisites for admission to candidacy must be supplemented in either of the following two ways:

Plan A: Completion of 12 hours of Masters Thesis Research (Chemistry 391) and submission of a satisfactory thesis; (2) completion of at least 30 hours of graduate credit (courses and Masters Thesis Research); and (3) two additional hours of Chemistry 381 (Seminar).

Plan B: Completion of six hours of Independent Literature Research Project (Chemistry 375); (2) completion of at least 30 hours of graduate credit (courses and Literature Research Project); and (3) two additional hours of Chemistry 381 (Seminar).

M.S. students should decide at the beginning of their program whether they will pursue Option A or Option B and inform the department and Graduate College of their decisions.

A reading knowledge of German is also expected.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

An undergraduate major in an appropriate field. Satisfactory scores on the Graduate Record Examination general (aptitude) section for those requesting financial assistance.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

It is expected that a student will ordinarily complete the following requirements for admission to candidacy by the end of the second year of residence: (1) at least 15 hours of research (Chemistry 491); (2) satisfactory performance in the cumulative examinations in his or her specialty field; (3) demonstration of basic competence in four fields of chemistry (analytical, inorganic, organic, and physical) through the biannual qualifying examinations or completion of prescribed courses at the University of Vermont; (4) three hours of teaching; (5) one year of residence; (6) the following courses are required: Chemistry 386 and 381 (four credits), three semester hours credit of advanced level work in three of the four areas of chemistry (analytical, inorganic, organic, and physical). The remainder of each student's program will be determined by a

departmental studies committee on the basis of qualifying examination performance, background, and research interests. In the normal course of events a student should expect to devote much of the first year to formal course work, and (7) maintenance of an overall point-hour ratio of 3.25.

MINIMUM REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

In addition to the above requirements a student must: (1) complete a doctoral research project, write an acceptable dissertation, and defend it; (2) present a total of 75 hours of credit in course work and dissertation research, and (3) make an oral and written presentation of an original research proposal, Chemistry 388 (at least six months prior to the submission of the dissertation). The student must also demonstrate a reading knowledge of scientific German and of either French, Russian, or computer programming.

COURSES OFFERED

201 Advanced Chemistry Laboratory (2-6). Lectures emphasize analytical instrumentation. Lab involves analytical, physical, and synthetic techniques. *Prerequisites:* 146, credit for or concurrent enrollment in 162 or 163. Four hours.

202 Advanced Chemistry Laboratory (1-8). Laboratory and discussion only. Problems require modern analytical, physical, and synthetic techniques. *Prerequisite:* 146, credit for or concurrent enrollment in 162 or 163. Note: Although it is highly recommended that 201 be taken before 202, in special cases this may not be necessary. Four hours.

211 Chemical Kinetics and Mechanism. Important aspects, applications of chemical kinetics. Theoretical, mathematical aspects covered at introductory level. Emphasis: interpretation of experimental rate laws in terms of mechanistic hypotheses for selected reactions. *Prerequisites:* 142, 162, 163. Three hours.

214 Polymer Chemistry. Polymer size and weight distributions. Synthesis and properties of organic and inorganic polymers. Kinetics of polymerization. Polymer characterization. Polymer formulation. *Prerequisites:* 144,162. Three hours. Allen.

221 Advanced Analytical Chemistry. A systematic survey of modern methods of chemical analysis. Principles and applications of analytical and molecular spectroscopy, electrochemistry, and separation techniques. *Prerequisites:* 162, 163. Three hours. Geiger, Goldberg.

222 Electroanaiytical Chemistry. Principles of modern electrochemical analysis, mainly finite current methods — voltammetry, polarography, chronoamperometry, cyclic voltammetry, double layer theory, electron transfer kinetics. *Prerequisite:*163. Three hours. Geiger.

224 Chemical Separations. Theory and practice of chromatographic separations. Emphasis on gas-liquid, liquid-liquid, and liquid-solid chromatography. *Prerequisite:* 221. Two hours. Geiger.

227, 228 Special Topics in Analytical Chemistry. Selected topics of current interest in the area of analytical chemistry. New techniques and methodologies, especially in chemical instrumentation. Credit as arranged. Geiger, Goldberg.

231 Inorganic Chemistry. Fundamental concepts, facts of inorganic systems. Molecular symmetry, models for structure, bonding, acid-base chemistry, descriptive chemistry of ionic, covalent compounds, introductory crystal field theory, reaction mechanisms. *Prerequisite:* 162. Three hours. Allen, Carrano.

232 Advanced Inorganic Chemistry. Selected topics include applications of group theory to vibrational spectroscopy and electronic structure, multiple bonding in main group and transition metal compounds, electrondeficient bonding, bioinorganic chemistry. *Prerequisite:* 231. Three hours. Allen, Carrano.

234 Organometallic Chemistry. Systematic survey of syntheses, properties,

structures, bonding, reactions of both main group and transition series organometallic compounds. Variation of structure and stability of metal-carbon bond throughout periodic system. *Prerequisite:* 231. Three hours. Allen.

236 Physical Inorganic Chemistry. Fundamental physical basis for spectroscopic techniques, other observable phenomena important to inorganic chemistry. Topics: ligand field theory, magnetism, magnetic resonance, Mossbauer spectroscopy, optical activity. *Prerequisites:* 163, 232. Three hours. Allen.

237, 238 Special Topics in Inorganic Chemistry. Advanced theoretical treatment of bonding and of physical properties of transition metal complexes; detailed treatment of inorganic reaction mechanisms. Credit as arranged. Allen, Carrano.

241 Advanced Organic Chemistry. Stereochemistry, reactivity criteria, reaction mechanisms and synthetic methods are stressed. Reactive intermediates such as carbanions, carbocations, carbenes, and free radicals are used to systemize mechanistic discussions. *Prerequisites:* 142, 162. Three hours. Krapcho, Kuehne, Strauss, White.

242 Advanced Organic Chemistry. Mechanistic considerations of reactions which include enolates, additions (such as cycloadditions, hydroborations, etc.), annelations, oxidations, rearrangements, eliminations, and approaches to multistep syntheses. *Prerequisites:* 241. Three hours. Krapcho, Kuehne, Strauss.

251 Physical Organic Chemistry. Structure-reactivity relationships, molecular properties and their interpretation. Methods and results of investigations of mechanisms of common organic reactions. *Prerequisites:* 142, 162. Three hours. Bushweller, Krapcho, White, Strauss.

257, 258 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. Credit as arranged. Bushweller, Krapcho, Kuehne, Strauss, White.

262 Chemical Thermodynamics. Systematic study of the application of thermodynamics to chemical problems. Concepts of statistical thermodynamics introduced. *Prerequisites:* 162, 163. Three hours. Flanagan.

263 Introduction to Quantum Mechanics. General consideration of quantum mechanics. Development of techniques pertinent to the application of quantum mechanics to chemical problems. *Prerequisites:* 162, 163. Three hours. Weltin.

264 Fundamentals of Spectroscopy. A general discussion of molecular spectroscopy, rotational and vibrational states of molecules, symmetry of vibrations; introduction to electronic spectra. *Prerequisites:* 162, 163, mathematics 121. Three hours. Weltin, Leenstra.

265 Statistical Mechanics. Development of statistical mechanics and its application to problems of chemical interest. *Prerequisites:* 162, 163; 263 recommended. Three hours. Flanagan.

266 Molecular Orbital Theory. Introduction to the Huckel molecular orbital method. Energy levels and orbitals, molecular properties and their interpretation. Effects of substituents on electronic structure. Extensions of Huckel method. *Prerequisites:* 142, 163. Three hours. Weltin.

267, 268 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. Flanagan, Leenstra, Weltin.

285, 286 Special Topics. Selected topics of an interdisciplinary nature, designed particularly for advanced undergraduate chemistry majors. Possible subjects include environmental chemistry, chemical technology, chemical economics. Offered as occasions arise. Variable credit.

342 Natural Products — The Alkaloids. The major classes of alkaloids surveyed from a biogenetic point of view. Classical and modern degradation methods, total syntheses and biosynthetic incorporation of labeled compounds. *Prerequisite:* Credit or concurrent enrollment in 242. Three hours. Alternate years. Kuehne.

344 Natural Products — The Terpenes. The chemistry of mono, sesqui, di and triterpenes, including degradations, structure proofs, total syntheses, rearrangement reactions and biogenesis. *Prerequisite:*

Credit or concurrent enrollment in 242. Three hours. Alternate years. Kuehne.

363 Quantum Chemistry. Applications of quantum mechanical techniques to problems of chemical interest. *Prerequisite:* 263. Three hours. Offered as occasion warrants. Weltin.

381, 382 Seminar. Current problems and literature. One hour.

386 Methods of Chemical Investigation. Introduction to advanced modern chemical methods. *Prerequisite:* Permission of department. Two hours.

388 Research Problem Conception and Solution. Independent origination of research problems and the methods of their solution. Required of all doctoral candidates. *Prerequisite:* Permission of department. This course shall be completed at least six months in advance of the Ph.D. dissertation defense, and in no case later than the end of the seventh semester of graduate studies at UVM. One hour.

395 Independent Literature Research Project. Reading and literature research culminating in the preparation of a comprehensive and critical review of a topic of current interest in chemistry. Credit as arranged.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

CIVIL ENGINEERING

Professors Cassell, Dawson, Hermance (chairperson), and Oppenlander; Associate Professors Downer, Hemenway, Laible, Olson; Adjunct Professor Knight.

The Department of Civil Engineering is presently conducting research in environmental engineering, structures, transportation, and urban planning.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

A bachelor's degree and the approval of this Department. Satisfactory scores on the Graduate Record Examination general (aptitude) section.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Specific course work may be required of those who lack a strong science background.

MINIMUM DEGREE REQUIREMENTS

The above prerequisites for acceptance to candidacy must be supplemented in either of the two following ways.

Plan A: Completion of advanced courses in civil engineering, mathematics, other approved courses and six to nine hours of thesis research for a total of 30 hours.

Plan B: Completion of 30 credit hours of advanced courses in civil engineering, mathematics, and other approved courses in lieu of the thesis.

The student should decide which option he/she intends to pursue at the beginning of his/her program.

RECOMMENDED CORE COURSES

It is recommended that the student's plan of study include one course in each of the following areas: advanced statistics, engineering economics, systems engineering, and computer-based numerical methods.

COURSES OFFERED

210 Airphoto Interpretation. Aerial photographic interpretation; principles of stereoscopic viewing, identification of airphoto features related to landform, vegetation, drainage, soils, topography; use of airphoto interpretation in soil identification. Three hours. Olson.

226 Civil Engineering Systems Analysis. Graph theory, dynamic programming, linear programming, scheduling, resource allocation, simulation; applications to public works problems; comparison of solution models and selection of models for complex problems. Three hours. Dawson.

227 Discrete Simulation. Discrete simulation using monte-carlo techniques and the GPSS simulation processor; mathematical modeling of systems; validation and sensitivity analyses. *Prerequisite:* Statistics 111, 141, or 151. Three hours. Dawson.

230 Community Planning Techniques. Size, spacing, and functions of cities; economic, social, and physical determinants of land-use elements; studies for urban planning; and the process of land-use planning Three hours. Oppenlander.

231 Community Planning Analysis. History and development of urban planning; approaches to planning: city design and appearance, quantitative methods, social welfare planning; plan implementation; organization and administration of planning agencies; financial planning. Three hours. Downer, Oppenlander.

232 Community Design. Basic principles and methods of planning and designing communities; site selection, elements of physical layout and design. Design projects dealing with community elements: subdivisions, industrial parks, new towns, etc. Three hours. Downer, Oppenlander.

233 Regional Planning. See Resource Economics 233.

240 Traffic Engineering Characteristics. Components of highway travel: driver, vehicle, roadway, environmental, and pedestrian characteristics; traffic flow and intersection characteristics; highway and intersection capacities; performance of traffic systems; traffic characteristic measurement. Three hours. Dawson.

241 Transportation Systems Engineering. Interdisciplinary aspects of transportation systems and their technological characteristics; mathematical analysis, synthesis of system problems; economic considerations; fiscal studies, financial planning; administration of transportation systems. Three hours. Oppenlander.

244 Urban Transportation Systems. Transportation planning; inventory, use, desire studies; techniques of travel forecasting, trip generation, distribution, assignment; planning, design, operation of mass transit systems; location, design of terminal facilities. Three hours. Oppenlander.

249 Solid Wastes. Significance of solid wastes from municipal, industrial, agricultural, mining; optimization and design of collection, disposal, recycle systems; and sanitary landfills, incineration, composting, material recovery. *Prerequisites:* Chemistry 5 and Physics 25. Three hours.

250 Environmental Facilities Design-Water. Design of water supply systems including: source evaluation, transmission, distribution; water treatment plant design; equipment selection, and wells. *Prerequisite:* 151. Three hours.

251 Environmental Facilities Design-Wastewater. Design wastewater conveyance and treatment facilities; sewage-treatment plant design, and equipment selection. *Prerequisite:* 151. Three hours.

252 Industrial Hygiene. Industrial hygiene problems; effects of pollutants on health; threshold limit values, and emphasis on the engineering evaluation of the hazard and control techniques. *Prerequisites:* Chemistry 5 and Physics 25. Three hours. Hemenway.

253 Air Pollution. Sources of air pollution, methods of measurement, standards, transport theory and control techniques used. Emphasis placed on source measurement and contaminant transport. *Prerequisites: Chemistry and Mathematics 21.* Three hours. Hemenway.

254 Environmental Quantitative Analysis. Chemistry and microbiology of water quality management, diffusion equilibria, reaction kinetics, acids and bases, colloids, enzymes, bacterial physiology, pollution indicator organisms. *Prerequisites:* Senior standing or permission of the instructor. Four hours. Hemenway.

255 Water Renovation Processes — Chemical/Physical. Design theory of chemical/physical processes for treating waters and wastewaters; mass transfer, coagulation/precipitation, sedimentation, filtration, mixing, absorption, ion exchange, and membrane processes; and pilot plant experimentation. *Prerequisites:* 150, 151 or graduate standing. Three hours.

256 Water Renovation Processes-Biological. Design theory of biological processes for treating waters and wastewaters; aerobic, anaerobic, photosynthetic processes; disinfection; and pilot plant experimentation. *Prerequisite:* 150, 151 or graduate standing. Three hours.

257 Analysis of Aquatic Systems. Quantitative study of biological, chemical and physical phenomena in lakes, streams and estuaries; and mathematical modeling applied to management of water quality. *Prerequisites:* 150 and 160. Three hours.

258 Environmental Facilities Design-Air. Advanced design principles for air pollution control equipment including scrubbers, precipitators, cyclones, and filter. *Prerequisites:* 150 and 252 or 253. Three hours. Hemenway.

259 Measurement of Airborne Contaminants. Quantifying airborne contaminants from processes and ambient levels. Laboratories demonstrate calibration and measurement, stack sampling and ambient air monitoring of specific contaminants. *Prerequisite:* 252 or 253. Three hours. Hemenway.

260 Hydrology. The basic theory of precipitation, run-off, infiltration, and ground water; precipitation and run-off data; and application of data for use in development of water resources. *Prerequisite:* 160 or Statistics 141. Three hours. Downer.

261 Open Channel Flow. Application of basic laws of fluid mechanics to flow in open channels; channel design, transition structures: riprap, culverts; gradually-varied flow problems including flood plain, floodway studies. *Prerequisite:* 160. Three hours. Downer.

263 Measurements in Applied Hydrology. Hydrologic experimental design; observational methods, equipment, problems in data reduction and handling techniques; application to instrumentation and study of the hydrology of a small watershed. *Prerequisite:* 163 or 260. Three hours. Downer.

270 Advanced Indeterminate Structures. Matrix analysis of framed structures; finite element theory and application in structural mechanics and hydrodynamics; emphasis on computer applications and numerical analysis techniques. *Prerequisites:* 171 and a basic knowledge of matrix algebra and computer programming. Three hours. Laible.

271 Prestressed Concrete Structures. Ultimate strength theory, emphasis on prestress effects; prestressed beam analysis, load balancing, column and pile design, bent analysis, yieldline theory, circular prestressing in domes, tanks; current design specifications. *Prerequisite:* 173. Three hours. Staff.

280 Applied Soil Mechanics. Use of soil mechanics in evaluation of building foundations, braced excavations, earth structures, lateral earth pressures, pile foundations, pier and caisson foundations, slope stability, construction problems. *Prerequisite:* 180. Three hours. Olson.

282 Engineering Properties of Soils. Study of soil properties influencing engineering behavior of soils; soil mineralogy, physiochemical concepts, plasticity properties, permeability, and compaction; laboratory study of soil index properties, permeability, compaction tests. *Prerequisite:* 180. Three hours. Olson.

290 Engineering Investigation. Independent investigation of a special topic under the guidance of a staff member. Prepara-

tion of an engineering report is required. Three hours.

333 Advanced Regional Planning. See Resource Economics 333.

360 Advanced Hydrology. Application of statistics to engineering hydrology; concept, use of instantaneous unit hydrograph; study of run-off models; flow through porous media; design techniques for water resources projects. *Prerequisites:* 260, Mathematics 271. Three hours. Offered as occasion warrants. Downer.

390 Advanced Topics in Civil Engineering. Special topics to intensify the programs of graduate students in civil engineering. Hours and credits to be arranged.

391 Master's Thesis Research. Credit as arranged.

CLASSICS

Emeritus Professors Bliss and Kidder; Professors Ambrose, on sabbatical leave 1983-84 (chairperson), Davison, Gilleland (acting chairperson 1983-84), and Schlunk; Assistant Professor B.S. Rodgers, Adjunct Professor R.H. Rodgers.

Current research interests include Early Greek Literature; the Attic orators; Greek Drama; archaeology; philosophy; Mycenaean and Homeric Greece; Cicero's rhetorical works; Vergil; lyric and elegiac poetry; Petronius; satire; Roman Imperial Families; Mythology; Etruscology; Medieval Studies.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major or minor or the equivalent; a reading knowledge of French or German.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours of advanced courses in Greek and Latin, six hours of which must be 381; six additional hours in Greek and Latin, History or Philosophy; thesis research (normally six hours). Comprehensive examinations in Greek and Latin translation, Greek and Roman history, and literature and philology are required. In addition to course work, students will have a reading list of authors in Greek and Latin.

Those who expect the department's recommendations to go on for a Ph.D. elsewhere must show competence in both German and French by the end of their first year of graduate study.

A program is also offered leading to the degree of Master of Arts in Teaching: See p. 00. Satisfactory scores on the general (aptitude) Graduate Record Examination are prerequisite for acceptance to candidacy for this degree.

COURSES OFFERED

GREEK

201 Greek Orators. Selected speechs of Lysias and Demosthenes. Three hours. B.S. Rodgers. Alternate years.

202 Greek Comedy. Two plays of Aristophanes. Three hours. Ambrose. Alternate years.

203 Greek Historians. Thucydides, Books I and II; selections from Herodotus and Xenophen's Hellenica. Three hours. Davison. Alternate years.

204 Greek Tragedy. Sophocles, *Antigone* and Euripides, *Medea,* or two equivalent plays. Three hours. Ambrose. Alternate years.

205 Greek Philosophers. Plato, *Republic,* Books I and II; selections from the Pre-Socratics and from Aristotle. Three hours.

B.S. Rodgers. Alternate years.

206 Greek Epic. Reading in the Iliad and Odyssey. Problems of epic composition and language together with mythological and historical background. Three hours. Schlunk. Alternate years.

LATIN

203 Republican Prose. Extensive reading in Caeser and Sallust, and in the speeches of Cicero. Three hours. Rodgers.

204 Epic Poets. Extensive reading in Lucretius, Vergil, Ovid, and others. Three hours. Ambrose, Schlunk.

227 Roman Lyric Poets. Selections from the works of Catullus, Horace, Propertius, Tibullus. Three hours. Alternate years.

251 Roman Letters. Letters of Cicero, Horace, and Pliny. Three hours. B.S. Rodgers. Alternate years.

252 Comedy. Two plays of Plautus and Terence. Study of the precursors of this literary form. Three hours. Ambrose. Alternate years.

253 Roman Oratory. Selections from Cicero's *De Oratore, Orator, Brutus,* and from his speeches. Historical development of forensic and other rhetorical canons. Three hours. Gilleland. Alternate years.

255 Historians of the Empire. Augustus, *Res Gestae;* Tacitus, *Annals,* I-IV; selections from Suetonius and Ammianus Marcellinus. Three hours. Davison. Alternate years.

256 Satire. Selections from Horace and Persius; Juvenal, Petronius. Study of the development of this literary form. Three hours. Gilleland. Alternate years.

271 Silver Latin. Extensive reading of post-Augustan authors not included in other advanced courses. Three hours. R. H. Rodgers. Alternate years.

GREEK AND LATIN

300 Pro-Seminar. Introduction to philology. Students will normally take this their first semester. Three hours. Ambrose.

381 Seminar. Intensive study at the graduate level of Greek and Latin authors not read in the candidate's undergraduate program. Credit as arranged.

391 Master's Thesis Research. Credit as arranged. Normally total 6 hours.

COMMUNICATION SCIENCE AND DISORDERS

Faculty: Professors Daniloff (Chairperson) and Wilson; Associate Professor Guitar; Assistant Professors Hoffman and Kramer; Lecturers Baker, Houghton and Turnbaugh; Staff: Freny Daruvala, M.A., (CCC-Sp) and Dinah K. Smith, M.A. (CCC-A).

The Faculty does research in language development and disorders, articulation processes and disorders, fluency disorders, speech perception, biofeedback and hearing disorders.

The Master of Science degree program in Communication Science and Disorders is accredited for speech-language pathology by the Education and Training Board of the American Speech-Language-Hearing Association (ASHA). The Eleanor M. Luse Center for Communication Disorders, which shares quarters with the department and is a primary practicum site, holds accreditation from the Professional Services Board of ASHA in Speech Pathology and Audiology. Students are required to fulfill academic requirements for the Certificate of Clinical Competence of the American Speech-Language-Hearing Association. Students may concentrate in either Speech-Language or Audiology. All students are supervised by clinically certified members of the faculty and staff of the E.M. Luse Center.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Baccalaureate degree from an accredited institution; satisfactory performance

on the general (aptitude) Graduate Record Examination. Completion of courses equivalent to CSD-80, 90, 101, 104, a course in statistics, a course in child psychology. These courses must be completed prior to enrollment in graduate courses.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of the written comprehensive examinations. Students will not be admitted to candidacy if practicum grades are incomplete.

MINIMUM DEGREE REQUIREMENTS

Thesis Option.

The student will take 30 hours of graduate level courses and receive six credits for conducting the research leading to an M.S. thesis. All research-oriented students will be encouraged to pursue this option.

Non-Thesis Option

The student will complete 36 hours of graduate level course work. For Speech Language Pathology, these include at least 21 credits in Speech Language Pathology, six credits in Audiology and three or more credits in Clinic Study. For audiology, 21 credits in audiology, six credits in Speech Language Pathology, and three or more credits in Clinic Study. In lieu of the thesis, students will enroll in two additional courses in communication: (1) a course in research methods which will require the completion of a clinical research project, and (2) three credits of Clinical Study (CSD 291-292), as a part of which students are required to give a diagnostic and/or therapeutic presentation which will be critiqued by the faculty as a whole.

COURSES OFFERED

251 Disorders of Speech. In depth survey of speech disorders: articulation, fluency, voice, etc. including those with functional as well as organic etiology will be considered. Includes 1 hour clinic laboratory. *Prerequisite:* CS&D-104. Four hours.

261 Disorders of Language. In depth survey of language disorders including aspects in reception and expressive use of the language. Includes 1 hour clinic laboratory as in CS&D-251. *Prerequisite:* CS&D-251. Four hours.

262 Measurement and Management of Communication Disorders. Study of the construction, application, interpretation and implementation of tests of communicative functioning. *Prerequisite:* CS&D-251. Three hours. Hoffman.

271 Audiological Assessment. Examination of basic parameters in measurement of hearing. Pure tone testing, masking, impedance, and speech evaluations. *Prerequisite:* CS&D-103 or permission of instructor. Three hours. Kramer.

272 Auditory Habilitation of Hearing Impaired Children. Survey of the handicapping effect of hearing disorders on the developing child and the principles of rehabilitation utilized for treatment of this disorder. *Prerequisites:* 15 credits in CS&D, including CS&D-104, 271. Three hours. Houghton.

281 Neuroanatomical Basis of Speech & Hearing. The neuroanatomical structures which underlie the formulation, production, and perception of speech are examined and related to language and speech behavior. *Prerequisites:* 9 credits in CS&D at the 200 level. Three hours.

287 Current Research in Normal and Disordered Language Acquisition. Recent advances in the study of child language.

Prerequisites: CS&D-104. Three hours.

290 Introduction to Research in Communication Science and Disorders. Study of hypothesis formation, review of research literature, and current research topics in Communication Science. Research project required. *Prerequisites:* At least 6 credits in CSD at the 200 level. Three hours. (Not offered for graduate credit.) Guitar.

291, 292 Clinical Study. Supervised practicum experiences with children and adults presenting disorders of speech, hearing, and language. *Prerequisites:* CS&D-261, 262. Credit as arranged.

293, 294 Seminar. *Prerequisite:* Permission of instructor. Variable credit.

371 Hearing Aids and Amplification. Types, characteristics, and methods of hearing aid selection and fitting; acoustics of earmolds; laws and consumer issues. *Prerequisite:* Graduate standing and instructor's permission. Three hours. Kramer.

372 Pathologies of the Auditory System. Disease, malformations, and lesions affecting the hearing mechanism. Learning to recognize, through case history, observation and clinical evaluation, the causes of hearing loss. *Prerequisites:* Graduate standing, instructor's permission and CS&D-80 (or equivalent). Three hours. Kramer.

373 Pediatric Audiology. Methods and techniques for hearing evaluations in children. The audiologist in the school system. *Prerequisite:* CS&D-103, graduate standing, and instructor's permission. Three hours. Kramer.

377 Habilitation and Rehabilitation Procedures for Hearing Impaired Adults. Electronic, social, linguistic, acoustic, psychological and pedagogical principles of rehabilitation of the hard of hearing. *Prerequisite:* CS&D-104, 271. Three hours. Houghton.

381, 382 Advanced Readings. Readings, with conferences, intended to contribute to the programs of graduate students in phases of communication science and disorders for which formal courses are not available. Credit as arranged, up to three hours each semester.

383 Seminar in Speech Pathology. An intensive study of selected topics in speech and pathology. *Prerequisite:* CS&D-251. Three hours.

384 Articulation Disorders. Etiology, diagnosis, pathology, and habilitation and rehabilitation of articulation of speech. *Prerequisite:* CS&D-251, (or equivalent). Three hours. Hoffman.

385 Voice Disorders. Study of normal and abnormal laryngeal anatomy and physiology as they relate to diagnoses and treatment of a wide variety of vocal pathologies. *Prerequisite:* 251. Three hours.

386 Neuromotor Disorders. Etiology, pathology, diagnosis, and principles of habilitation of cerebral palsy and other CNS pathologies. Emphasis on disorders of oral communication and associated disorders. *Prerequisite:* CS&D-101, 251 (or equivalent).

387 Seminar in Language Disorders. Identification, evaluation, and rehabilitation procedures for children with language disabilities. *Prereqisite:* CS&D-104. Three hours.

388 Seminar in Stuttering. Study of adult and child fluency disorders which focuses upon symptomatology, etiology, diagnosis and rehabilitation of stuttering patients. *Prerequisite:* 104. Three hours. Guitar.

389 Seminar in Aphasia in Adults. Study of the symbolic and communicative disorders in aphasic adult patients. Rehabilitation strategies, principles, and procedures are presented. *Prerequisite:* 251. Three hours. Staff.

390 Advanced Audiology. Audiological procedures: site of lesion testing, electrical response testing, impedance, adaptation, recruitment, and special speech tests. *Prerequisite:* Permission of Instructor and CS&D 271 (or equivalent). Three credits. Mitchell Kramer.

391 Master's Thesis Research. Credit as arranged.

COMPUTER SCIENCE

Professors Absher, Dawson; Associate Professor Hegner; Assistant Professors Margolis and Train; Lecturers Charbonneau, Fischl, Singh, and Thomas.

Research activities in Computer Science encompass a broad range of topics including Formal Language Theory, Operating Systems, Simulation, Architecture, and Performance Evaluation.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Bachelor's degree from an accredited institution. Satisfactory scores on the general (aptitude) portion of the Graduate Record Examination. Mathematics 21, 22, 124 or the equivalent; Computer Science 11, 12, 101 or the equivalent.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Mathematics 104; Computer Science 102, 103, 104.

MINIMUM DEGREE REQUIREMENTS

Thirty semester hours of acceptable graduate credit. Thesis is optional. Required courses are Computer Science 201, 202, 222, 241, 242, and Electrical Engineering 231. CS 311 and 312 are recommended for the student selecting the non-thesis option. Up to nine hours from an area of minor concentration may be used to fulfill degree requirements.

COURSES OFFERED

200 Discrete Simulation. See Civil Engineering 227.

201 Operating Systems (3-0). Introduction to principal components and algorithms in operating systems design, implementation. Comparison of memory, processor, device and file management techniques. Protection and security schemes. Synchronization primitives. *Prerequisite:* 222. Three hours. Staff.

202 Compiler Construction (3-0). Organization of a compiler including compile and run time symbol tables, lexical scan, syntax scan and object code generation. *Prerequisite:* 104. Three hours.

204 Advanced Systems Programming. Advanced study and research in a selected area of systems programming. *Prerequisite:* 201. Three hours.

222 Computer Architecture (3-0). Architecture of computing systems. Levels of computer description. Taxonomy of machines. Addressing structures, memory concurrency, processor concurrency. Hardware features for various software systems. Hardware, software, firmware tradeoffs. *Prerequisites:* 102, Math 104, EE 231 or 237. Three hours. Train.

223 Introduction to Formal Language Theory. (Same as Math 223.)

241 Theory of Automata. (Same as Math 218.)

242 Introduction to the Theory of Computing. (Same as Math 217.) *Prerequisite:* 241.

295 Special Topics in Computer Science. Lectures, reports and directed readings on advanced topics. *Prerequisite:* Permission of instructor. Three hours.

311 Literature Seminars. Introduction to the Computer Science research literature through directed readings. A complete literature survey and state of the art report is required of all students. *Prerequisite:* 12 hours of Computer Science courses

numbered 200 or above. Three hours.

312 Problem Seminars. Solution of advanced problems of current interest in Computer Science. *Prerequisite:* 311. Three hours.

391 Master's Thesis Research. Credit as arranged.

EDUCATION

Professors Abruscato, Agne, Boller, Carlson, Clements, Conrad, Ducharme, Fox, Gobin, Grams, Hanley, Hunt, Leggett, McKenzie, Nash, Peterson, Petrusich, Rippa, Shiman, Tesconi; Associate Professors Barbour, Burrell, Coward, Erb, Fitzgerald, Goldhaber, Griffin, Hasazi, Johnston, Lang, Larson, Letteri, Meyers, Nevin, B. Nichols, Paolucci-Whitcomb, Pierce, Ponzo, Rathbone, E. Rathbone-McCuan, Sandoval, Shelton, Thompson, Williams, Young; Assistant Professors Bright, Chase, Cheney, Clarke, DeWeaver, Edwards, Holmes, Hood, Jameson, McEntee, O'Donnell, Roberts, Rose, Smith, Stevenson; Lecturers, Burdett, Christie, Geller, Royce, Michael, Watson, Wood, Extension Associate Professor E. Nichols.

The College of Education and Social Services offers numerous opportunities for graduate study in preparation for special competencies in a variety of fields which include practica, research problems, and in-service relationships with cooperating school systems and social service agencies. The programs in various areas of specialization are described below.

Satisfactory performance on the general (aptitude) section (verbal and quantitative) of the Graduate Record Examination is required for admission to the Graduate College for students pursuing the degrees of Master of Education, Master of Science, and Doctor of Education.

THE DOCTOR OF EDUCATION IN EDUCATIONAL ADMINISTRATION

A Doctor of Education (Ed.D.) degree is offered in Educational Administration. This is an applied research based program for professionals serving in educational management positions in schools and school-related organizations; e.g., state departments of education, professional associations, higher education, and human service agencies.

Program emphases include: the design and implementation of educational research; adaptation of theoretical constructs and models to educational settings with attention to small systems; knowledge and skills in inter-organizational relationships; theory and research; conflict and resource management; budget planning and policy studies; and program and personnel evaluation.

This program has been designed to respond to the expanding demands placed on educational administrators in educational and human service organizations where they are increasingly expected to design and supervise local research and varied evaluative studies; interpret and apply recent national research findings; analyze and apply governmental regulations and court decisions; develop organizational responses to emerging social expectations; organize and lead staff development programs; understand and apply broad based economic principles and social and fiscal policy; develop and manage budgets; assess and respond to the psychological needs of educational consumers; employ effective interpersonal management and decision-making skills.

Prerequisites for admission and degree requirements are given on page 51-52.

The core courses required for first year students, EDAP 409, 432, 437 and EDFS 455, are described on pages 110 and 103. Courses in Administration and Planning begin on page 109.

Detailed information on the course of study is available from Program Director, Robert V. Carlson, Ed.D., Professor of Organizational, Counseling, and Foundational Studies.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF EDUCATION

Satisfactory scores on the general (aptitude) portion of the Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF EDUCATION

Eighteen hours of Education and related areas or appropriate professional certification. The Education course prerequisites may not apply to the Student Personnel Services in Higher Education, Administration and Planning, or Interdisciplinary Major Programs in OHRD. This is particularly true of persons seeking positions which do not require public school certification.

MINIMUM DEGREE REQUIREMENTS

Eighteen hours in courses in Education numbered above 200, including a minimum of six graduate hours in the foundations of education, 12 additional hours in approved courses or six additional hours and thesis research; a year of successful experience in teaching or in a related educational activity.

DEPARTMENTS

I. PROFESSIONAL EDUCATION AND CURRICULUM DEVELOPMENT

In the event of restrictions on enrollment, preference will be given to Vermont residents holding professional positions in education and social services.

Curriculum and Instruction This master's program is designed to develop leadership in such educational settings as teaching, curriculum theory, curriculum development, and related areas of research for elementary and secondary public and private school settings. The program is also appropriate for those with teaching roles in human services agencies.

Programs are developed to provide a comprehensive background in fields basic to instruction and curriculum development as well as the application of that knowledge to a specialized field. They include courses aimed at the examination and improvement of instructional practices in elementary and secondary schools, and understanding of curriculum theory and the application of curriculum theory to instruction and curriculum development. Opportunities for independent study and research are encouraged in the specializations represented in the course offerings of the Department of Professional Education and Curriculum Development.

As in the education of teachers enrolled for pre-service degrees, work at the

graduate level also draws upon other divisions of the University, thus enabling the College to develop strong programs of professional education which include academic offerings in the various teaching fields in elementary and secondary education.

Degree concentrations, in addition to those listed below, can be developed on an interdisciplinary basis responding to student strengths and needs.

Courses in teacher education include 211, 217, 218, 225, 227, 228, 241, 242, 244, 248, 256, 257, 259, 270, 271, and 333.

Inquiries regarding these programs should be addressed to the Chairperson.

Within the Curriculum and Instruction Program Area, it is possible to concentrate in school library media. This satisfies the need for the practicing teacher to cope with computer-assisted instruction, programmed learning, tape cassettes, film, and video tape. The individual will pursue a specialization that allows the acquisition of a perspective that broadens that potential use of a school media-library. Depending upon the course work selected, the graduate could become certified as an elementary or secondary school librarian. A minimum of 18 hours of study in library and media courses is necessary for a concentration in school library-media education. Minimally, the graduate is conversant with the tools available to the classroom teacher in a school library-media center and the graduate has practical application of those skills.

Inquiries regarding this program should be addressed to Professor Helene Lang.

Reading and Language Arts The purpose of this program area is to prepare teachers and specialists in the field of reading. Classroom teachers, reading specialists or consultants, supervisors and administrators are responsible for developing programs which will enable every student to attain his/her maximum proficiency in the use of reading and language. To meet this end, several courses have been devised which focus on classroom reading instruction and reading difficulties. Through the Reading Center, students also have opportunities for laboratory experiences as well as for research and study in reading, literature, and language arts.

Courses in reading and language arts include 222, 223, 234, 275, 276, 378, and 379.

Inquiries regarding this program should be addressed to Professor Lyman Hunt.

II. SPECIAL EDUCATION, SOCIAL WORK, AND SOCIAL SERVICES

The Special Education Graduate Program in this department prepares special education teachers to serve children and youth with mild, moderate, and severe handicapping conditions. The following concentrations are available:

Intensive Special Education The Intensive Special Education concentration prepares educators of the moderately, severely, and multi-handicapped. Only certifiable educators or experienced mental retardation service providers are considered. The course sequence consists of 30 credit hours of course work, laboratory (practicum) experience, and internship. Courses in Intensive Special Education include: EDSP 217, 228, 290, 301, 302, 310 and 386. A six credit summer course is followed by a full-time year or a part-time sequence of at least two years.

Essential Early Education The Essential Early Education prepares educators of preschool handicapped children. Only certifiable educators or experienced service providers are considered. The course sequence consists of 30 credit hours of course work, laboratory (practicum) experience and internship. Courses in Essential Early Education include: EDSP 217, 228, 301, 302, 310 and 386. A six credit summer course is followed by a full-time year or a part-time sequence of at least two years.

Elementary and Secondary Special Education The Elementary and Secondary concentrations prepare Mainstream, Special Class Resource Teachers, and Vocational Educators. Only certifiable educators currently employed as service providers are considered. The course sequence consists of 30 credit hours of in-service course work and laboratory (practicum) experience. Courses include: EDSP 301, 310, 312, 333, 319 and approved electives.

In addition, a Certificate of Advanced Study (sixth year certificate), a 30 hour program beyond the master's degree, is offered with a Consulting Teacher/ Learning Specialist concentration (see page 34).

Inquiries regarding the Special Education Graduate Program should be addressed to the Chairperson.

III. ORGANIZATIONAL, COUNSELING, AND FOUNDATIONAL STUDIES

This department consists of Administration and Planning, Counseling, Student Personnal Services in Higher Education, and Foundational Studies Programs. In addition to the four previously mentioned graduate level programs, a fifth option is available which is referred to as an Interdisiplinary Major in Organizational and Human Resource Development. Inquiries regarding this program and the specialization listed below should be addressed to the Chairperson.

Programs

Administration and Planning This program is designed to prepare administrators and planners for public schools, educational and social agencies, and middle management positions in higher education. The M.Ed. program usually requires 30-36 credit hours of courses including seminars, practicums, and research experiences. The Certificate of Advanced Study (C.A.S.) Program usually requires 30-36 credit hours of study beyond the M.Ed. requirements.

Courses with an administration/planning focus include 264, 266, 268, 280, 295, 332, 333, 335, 337, 352, 353, 354, 355, 356, 358, and 386.

Student Personnel Services in Higher Education This program assists individuals to work within the broad field of student development in higher education. Graduates serve as administrators, advisors, and counselors in colleges and universities. Their shared mission is the improvement of educational programs, purposes, and services for students; this mission transcends any individual differences among the goals and placements of the graduates of the program.

The program offers a core curriculum to students. That core enables all students to gain an understanding of: the purposes and administration of student personnel services; theories and practices of student development; the organization and administration of colleges and universities; and the history and goals of

higher education in America.

In addition to this academic core, all students partake in practical experiences which help them to integrate their conceptual knowledge with the real requirements of administration and counseling in higher education. To implement this aspect of the program, a comprehensive array of practica has been developed in offices and departments at the University of Vermont, and at near-by colleges. Students choose those experiences which best meet their needs for professional development.

The core curriculum is augmented by the selection of additional course work that meets the particular needs of students. Students can develop a particular skill area within student personnel service: for example, counseling. Or they can create general programs that enhance their ability to be successful in diverse roles. This opportunity belongs to every student — to build a unique program upon the foundation of the core curriculum.

Courses in the student personnel services program include 200, 295, 360, 362, 383, 385, and 387.

Foundations of Education This degree program area is designed to meet the personal-professional needs of the following students: (1) research scholars who wish to undertake protracted and intensive study of education as a disciplined, systematic field of inquiry; (2) in-service teachers and community college educators who are interested in the broad theoretical foundations of education, beyond specific specialization; (3) administrators, school-board members, and community leaders who wish a broad background in the theoretical-practical underpinings of education; (4) laymen who wish to study broadly the field of education in order to make reasoned and critical judgments about the many educational proposals to which they are constantly exposed; (5) professionals outside the field of education (for example, journalists, writers, clergymen, businessmen) who want a general, multi-disciplinary understanding of education in all of its components; and (6) innovators who are interested in critical, in-depth studies of alternative educational structures (for example, inner-city and rural community schools), and (7) individuals concerned with international education and service to developing countries.

Courses in foundations of education include 204, 205, 206, 209, 252, 255, 302, 303, 314, 354, and EDSS 313 and EDLS 377.

Inquiries regarding this program should be addressed to Professor David A. Shiman.

Interdisciplinary Major This degree program is for students who wish to pursue an individually designed, integrated program of study. The program draws primarily from graduate courses in Administration and Planning, Counseling, Student Personnel Services in Higher Education, and Foundational Studies but may include courses from other departments within the College and the University. A minimum of 36 credit hours is required for completion of the program. The program is ideally suited for persons whose personal and professional development requires a combination of course work not readily available in other graduate programs, or for individuals who plan to assume new or emerging roles in the fields of Education or Social and Human Services.

Applicants should have a clear understanding of how the Interdisciplinary

Program will serve their career goals. For this reason, major emphasis in admission is placed upon the applicant's Statement of Purpose. Applicants are strongly encouraged to contact the Department of Organizational, Counseling, and Foundational Studies, 228 Waterman Building, prior to making application for admission. Detailed information about the program and admissions criteria will be supplied upon request.

Counseling Program (MASTER OF SCIENCE) This degree program provides preparation for the individual who intends to become a school counselor (program is state-approved for certification in school counseling); a director of pupil personnel services, or a community counselor. The program, which requires 42-48 credit hours of course work, covers four broad areas of study: (1) personal growth and development, self-awareness, interpersonal relations, physical and mental health; (2) the foundations and dynamics of human development and behavior; (3) theory and skill for individual, group, and family counseling; (4) administrative and planning concepts and skills as related to guidance, social service, and psychological education programs. Particular emphasis is placed upon the implementation of theory in practice with opportunities provided for student-counselors to work under supervision in schools and community agencies.

Program planning is done with the assistance and approval of a faculty advisor. When relevant, the student may take courses from other areas of the University.

Courses in the counseling program include 220, 221, 258, 291, 293, 295, 350, 351, 368, 370, 374, 381, 384, 386, 388, 389, 390, 393, 394, 397.

In addition to the general admissions procedures, a personal or group interview is required for this program. For a more detailed description of the program, contract Professor Zander Ponzo, Department of Organizational, Counseling, and Foundational Studies, 228 Waterman Building.

COURSES OFFERED

The College of Education and Social Services offers the following courses on a program basis. Departmental permission is required for enrollment.

200 Contemporary Issues. Designed so that its content and structure may accommodate special issues not especially appropriate within the boundaries of an existing course. *Prerequisites:* Twelve hours in education and related areas. Two to six hours.

295 Laboratory Experience in Education. Supervised field work designed to give student experience in specialized areas for their professional development. *Prerequisite:* Permission of the Coordinator of Professional Laboratory Experiences. Credit as arranged.

319 Internship for Specialized Personnel in Education. Students will undertake an approved internship in an institution which reflects the particular area of interest and needs of the student. *Prerequisite:* Permission of instructor. Credit as arranged.

380 Professional Problems in Education. Designed to cover selected educational problems in depth. The major emphasis will be on intensive and critical analysis of the literature and practice in a given area. Three hours.

382 Teaching Internship. Supervised teaching experiences on a full-time basis, with related seminars in teaching subject. *Prerequisite:* Permission of coordinator of Professional Laboratory Experiences, College of Education and Social Services. Three to eight hours.

391 Master's Thesis Research. Thesis topic must be approved by a faculty committee. Credit as arranged.

397 Problems in Education. Individual work on a research problem selected by the student in consultation with a staff member. *Prerequisites:* Twelve hours in education and related areas; endorsement by a sponsoring faculty member. Credit as arranged.

EDSS—EDUCATION

211 Educational Measurements. The essential principles of measurement in education. Topics include validity, reliability, principles of test construction, item analysis and analysis of standardized tests as they apply to the classroom. *Prerequisite:* Twelve hours in education and related areas. Three hours.

238 Teaching for Global Awareness. Ways of teaching about global issues: peace and prevention of war; social, economic justice; environmental harmony. Development of curriculum materials. Links between local and global concerns. *Prerequisite:* Twelve hours of education and related areas. Three hours.

245 Applications of Microcomputers in Elementary & Secondary School Curricula. For elementary, secondary educators with experience in simple programming. Design of instructional procedures, integrating computers into school curriculum. Use of computer software to teach basic skills, reasoning, thinking skills. *Prerequisites:* CS 3 or equivalent and permission of instructor. Three hours. Agne, Abruscato, Erb, Watson.

248 Educational Media. Modern instructional aids, theory and practice; educational media related to psychology of teaching and learning. *Prerequisite:* Twelve hours in education and related areas. Three hours.

313 Statistical Methods in Education and Social Services. Basic concepts of descriptive and inferential statistics. Topics: frequency distributions; measures of central tendency, dispersion; correlation, hypothesis testing. Application of concepts to educational situations. Three hours.

333 Curriculum Concepts, Planning & Development. Overview of conceptions of curriculum for elementary and secondary education; examination of contemporary curriculum trends, issues; processes for initiating, planning, developing curriculum activities and programs. *Prerequisite:* Twelve hours of education or permission of instructor. Three hours.

336 Professional Writing. Problems in writing faced by professionals in educational and human service settings. Students write reports, critiques, reviews; analyze examples of published work; receive detailed critiques of their work. Three hours.

363 Seminar in the Analysis of Curriculum and Instruction. A case study analysis of the design, implementation and evaluation of selected curricular and instructional improvements. *Prerequisites:* Graduate standing, Ed.D. students have priority. Three hours.

EDLS—LEARNING STUDIES

212 Child and Adolescent Psychology. Children and adults as emerging individuals. Impact of socio-cultural ethics, values, institutions on individuals. Topics: human needs, values, self concept, personal freedom, bureaucratic society, cross cultural issues. *Prerequisite:* Twelve hours in education and/or related areas. Three hours.

377 Seminar in Educational Psychology. Personal values, attitudes, beliefs related to learning. Psychological research of the teaching-learning process. Research use in analysis of educational processes. Applications for educational settings. *Prerequisite:* Twelve hours in education and related areas. Three hours.

EDFS—FOUNDATIONS

204 Seminar in Educational History. Selected topics in history of education. Education in democratic and authoritarian social orders. Topics: education of women, black heritage, American higher education in transition. *Prerequisite:* Twelve hours in Education and related areas or permission of the instructor. Three hours.

205 History of American Education. Educational principles and practices in the United States as they relate to the main currents of social history. Key ideas of historic and contemporary significance. *Prerequi-*

site: Twelve hours in education and related areas or permission of the instructor. Three hours.

206 Comparative Education. Cross-cultural examination of education and selected social services in several countries, e.g. China, U.S.S.R., England. Themes include: ideology, social class, and social change. *Prerequisite:* Twelve hours in education and related areas. Three hours.

209 Introduction to Research Methods in Education and Social Services. Seminars and research projects. Methods of historical, descriptive, experimental, quasi-experimental, field studies, and survey research. Three hours.

252 Seminar in Aesthetic Education. A critical examination of aesthetic values in contemporary society. The aesthetic quality of natural and built environment with implications for present and future educational practice will be given special attention. *Prerequisite:* Twelve hours in education and related areas. Three hours.

255 School as a Social Institution. Examination of the school and related social institutions, focus on themes, including: social class, race, ethnicity, socialization, role of the family, social change. *Prerequisite:* Twelve hours of education and related areas. Three hours.

302 Philosophy of Education. Critical examination of key beliefs and values in current philosophies of helping. e.g. phenomenological, behavioral, holistic, as practiced in a variety of educational and social service institutions. *Prerequisite:* Twelve hours in education and related areas. Three hours.

303 The Ethics of Helping Relationships. Clarification of ethical dimensions of professional rights and obligations for educators, counselors, administrators, other helping professionals. Examination of selected ethical controversies currently facing the helping professions. *Prerequisite:* Twelve hours in education and related areas. Three hours.

314 Modes of Inquiry. A critical analysis of the various conceptual and methodological foundations of theory and practice in education and the human services. *Prerequisites:* Twelve hours in education and related areas. Three hours.

354 Anthropological Perspectives on Education and Social Services. Cultural anthropology and its relationship to education, popular culture, human services. Anthropological perspective on teaching, learning, helping in selected American institutions. Cultural appraisal of media influences on education. *Prerequisite:* Twelve hours in education and related areas. Three hours.

455 Social Processes and Educational Institutions. Relationships among ideology, social control, social class, policies, practices within educational institutions. Research related to curricular orientation, evaluation and selection, and school and classroom organization. *Prerequisite:* Doctoral level standing. Three hours.

EDEL—ELEMENTARY EDUCATION

222 Improvement of Reading Instruction in the Elementary School. Analysis of philosophies, program, and instructional practices for teaching reading. Examination and evaluation of basal textbook, individualized, and specialized reading programs. *Prerequisites:* Twelve hours in education and/or related areas including an introductory course in reading or permission of the instructor. Three hours.

234 Literature and Language for Children and Youth. Characteristics, interests, reading habits of children and youth; selection, evaluation of literature. Organizing book units for teaching literature, for content areas. Emphasis on development of oral, written expression. *Prerequisite:* Twelve hours in education and related areas or consent of instructor. Three hours.

241 Science for the Elementary School. Examination of elementary school science programs. Emphasis on methods and materials relating to construction, use of science units for children in grades K-6. *Prerequisite:* Twelve hours in education and related areas and permission of instructor. Three hours.

242 Modern Trends in Elementary Education. Modern educational principles, instructional practices in elementary schools including communication in the classroom, interaction between students and teachers, materials, emerging trends affecting the elementary school. *Prerequisite:* Twelve hours in education and related areas. Three hours.

244 Social Studies in the Elementary School. Study of literature, research, and problems in teaching social studies in the elementary school. *Prerequisite:* Twelve hours in education and related areas. Three hours.

256 Methods and Materials in Elementary School Mathematics. Evolution of mathematical concepts, notations. Meaning of numbers, number systems. Theory underlying fundamental operations, metric measurement, analysis of modern approach to mathematics. Manipulative approach to teaching mathematics. *Prerequisite:* Twelve hours in education and related areas. Three hours.

270 Kindergarten Methods and Organization. Objectives, organization, curriculum, methods and materials, and relationships of kindergarten to Head Start and other preschool experiences. *Prerequisite:* Twelve hours in education and related areas. Three hours.

271 Kindergarten Education with Laboratory Experiences. Designed to acquaint the prospective kindergarten teacher with educational research conducted by Piaget, Bruner, Montessori, and others with experiences provided for working with children of kindergarten age. *Prerequisite:* Twelve hours in education and related areas. Three hours.

375 Analysis of Reading and Related Difficulties. Analysis and evaluation of learning difficulties with emphasis on reading and writing; nature of difficulties; procedures and materials for assessing reading performance. Involvement with children is required. *Prerequisite:* Six hours in reading and three hours in education or permission of instructor. Three hours.

376 Laboratory Experiences in Reading and Related Language Instruction. Approaches for prevention, correction of reading and written language difficulties. Supervised teaching of individuals and/or small groups experiencing reading and language problems. Apprenticeships in reading instructional programs. *Prerequisite:* 375. Three hours.

378 Advanced Study and Research in Reading and Related Language Arts. Survey of research, comparison and evaluation of emerging programs design and development of projects in reading. *Prerequisite:* Fifteen hours in education including nine hours in the field of reading and language education, or permission of instructor. Three hours.

379 Seminar in Reading Instruction. Study of reading relative to total curriculum. Significant trends, concepts related to specific problems, programs in reading and language arts instruction; role of supervisor and reading consultant. *Prerequisites:* Fifteen hours of education including nine hours in the field of reading and language education or permission of instructor. Three hours.

EDSC—SECONDARY EDUCATION

217 Secondary School Curriculum. Principles and problems in curriculum development. An analysis of recent curricular innovations in American secondary schools. *Prerequisite:* Twelve hours of education and related areas. Three hours.

223 Reading Programs in Secondary Schools and Colleges. Relationship of reading to learning: study of organization, instructional procedures, and materials for developing reading improvement programs for secondary and college students; reading in content areas. *Prerequisite:* Twelve hours in education and/or related areas or consent of instructor. Three hours. (Also offered for undergraduates under 137.)

225 Teaching Social Studies in Secondary Schools. Includes multiple teaching modes, questioning techniques, micro-teaching laboratory, analysis of historical content to determine students' prerequisite cognitive skills and processes for construction of historical scenarios. *Prerequisite:* Twelve hours of education and related areas. Three hours.

227 Teaching Science in Secondary Schools. Consideration of science curricula for grades 7-12. Topics may include: teaching science as problem-solving, research in science teaching, evaluation strategies, instructional techniques, affective education through science. *Prerequisites:* Twelve hours in education and related areas and permission of instructor. Three hours.

228 Literature in the Junior-Senior High School Curriculum. (Literary Criticism for Teachers). Three hours.

229 Communicative Arts in Secondary

Schools. (Teaching English in Secondary Schools). Three hours.

257 Teaching Mathematics in Secondary Schools. Three hours.

259 Teaching Foreign Language in the School. (Secondary) Three hours.

282 Seminar for Prospective Teachers of English. (See English 282.)

294 Seminar for Prospective Teachers of Communications. (See Communication 294.)

303-304 Problems and Research in Teaching Secondary School English. (See English 303-304.)

EDMU—MUSIC EDUCATION

240 Musical Creativity in the General Music Class. Designing a course of study for the general music class. Developing musical concepts and perception through individual differences. Aural approach through class performance on recorders. *Prerequisite:* An undergraduate major in music education or permission of instructor. Three hours.

243 Recent Trends in Music Education. Study of recent thought and practices in music education. Examination of current trends. *Prerequisite:* An undergraduate major in music education or permission of instructor. Credit variable, one to four hours.

253 Practicum in Music Education. Current methodology in music education for music specialist and classroom teacher. Each year the emphasis will be in a different area of concentration. *Prerequisites:* An undergraduate major in music education or elementary education and teaching experience or permission of instructor. Credit variable. Course may be taken for one to four hours each semester and may be repeated for a maximum of eight hours of credit.

290 Basic Concepts in Music Education. Disciplinary backgrounds; historical and philosophical foundations; fundamental consideration of the functions of music in the schools; development of a personal philosophy. Three hours.

390 Organization and Administration of Music Education. Study of the organization and administration of vocal and instrumental music in the public schools. *Prerequisites:* Graduate standing in music education and teaching experience or consent of instructor. Three hours.

ECHD—EARLY CHILDHOOD AND HUMAN DEVELOPMENT

260 Family Ecosystem. The family will be viewed in and as an environment for human development. The family ecological approach will be applied to practical family concerns. *Prerequisite:* Senior standing or permission of instructor. Three hours. Edwards.

263 Advanced Child Development. A survey of the professional literature in child development with special emphasis on the influence of early life experiences throughout the life cycle. *Prerequisite:* 80-81 or equivalent. Three hours. Goldhaber.

264 Contemporary Issues in Parenting. Contemporary cultural factors that influence adult lifestyles and their relationship to successful parenting. *Prerequisite:* Nine hours in human development or permission of instructor. Three hours. Goldhaber, Jameson.

265 Teaching Human Development. Designed for individuals who teach or plan to teach human development. Emphasis on group-building skills and interpersonal relationships. *Prerequisite:* Six hours in human development and permission of instructor. Three hours. Barbour.

266 Seminar in Human Development. Intensive study of issues in human development and their application in a wide variety of professional areas. May be taken more than once up to a maximum of 12 credits. *Prerequisites:* Junior standing, nine hours of human development or equivalent. Three hours.

281 Infancy. Development and rearing from conception to 18 months and the relationship to subsequent development. *Prerequisites:* Nine hours in human development, nutrition, and physiology or biology or permission of instructor. Three hours. Shelton.

282 Seminar in Physical Development and Health in Later Life. Physical manifestations of senescence, anatomical and physiological development, longevity, vitality, health care, nutrition, chronic conditions and disability. *Prerequisite:* ECHD

181 or permission. Three hours. Grams.

283 Personal and Family Development in Later Life. Cognitive development, intellectual performance, work and achievement, retirement and leisure, personal, development, self-esteem, coping mechanisms, dying, couples, intergenerational and kinship issues. *Prerequisite:* 181 or permission. Three hours. Grams.

284 Public Policy and Programs for Elders. Demography of aging, social institutions and roles, policy and program implementation, income maintenance, housing, health care, social services, transportation, legal and political issues. *Prerequisite:* 181 or permission. Three hours. Grams.

291 Special Problems. Reading, discussion, and special field and/or laboratory investigations. *Prerequisite:* Departmental permission. Students may enroll more than once for a maximum of twelve hours. One to six hours.

295 Special Topics. Lectures, laboratories, readings or projects relating to contemporary areas of study. Enrollment may be more than once; accumulate up to twelve hours. *Prerequisite:* Departmental permission.

296 Field Experience. Professionally oriented field experience under joint supervision by faculty and business or community representative. Credit arranged up to fifteen hours. *Prerequisite:* Departmental permission.

EDPE—PHYSICAL EDUCATION

201 Administration of Athletic Programs. Background for effective administration of the athletic program of schools. Including scheduling, budgeting, management, equipment, policy, public relations, and education justification. *Prerequisites:* Twelve hours of education and psychology. Three hours.

203 Principles of Physical Education. Principles basic to sound philosophy of physical education for appraisal of historical development; relationship to health education, recreation and other areas; foundation and functions of physical education. *Prerequisites:* Admission to the program and junior standing. Three hours.

240 Principles of Motor Learning and Human Performance. Nature of motor learning; factors affecting motor learning, (motivation, emotion, stress); concepts of transfer, retention; alternatives in teaching, coaching methodologies based upon applied principles in motor learning. *Prerequisites:* 166 and EDSS 145 or 146. Three hours.

241 Seminar in Physical Education and Athletics. Examination and analysis of contemporary issues and trends in physical education and athletics not especially appropriate within the boundaries of an existing course. *Prerequisite:* Twelve hours in physical education and related areas. Variable credit (two-four hours).

253 Curriculum Design in Health and Physical Education. Philosophy, techniques of curriculum innovation in health and physical education. Inter-relationships between student needs and interests, teaching methodology, evaluative procedures, community involvement, administrative organization patterns. *Prerequisites:* Junior standing and 104, 105, 46 or 155. Three hours.

260 Adaptive Physical Education. Recognition, prevention, correction of functional, structural deviations from normal body mechanics. Organization of programs adapted to needs of handicapped individuals in both special class and mainstreamed settings. *Prerequisite:* 155, 104, 105 or equivalent teaching experience. Three hours.

EDHE—HEALTH EDUCATION

208 School Health Programs. Organization of the total school health program. Problems and administration in the area of school environment, health services, health education, and school-community relationship. *Prerequisite:* 46 or equivalent. Three hours.

EDLI — LIBRARY SCIENCE

272 Public and School Library Services. *Prerequisite:* Twelve hours in education and related areas, or permission of instructor. Three hours.

273 Cataloging and Classification. *Prerequisite:* EDLS 272 or equivalent. Three hours.

274 Reference Materials and Teaching the Use of Libraries. *Prerequisite:* EDLS 272 or equivalent. Three hours.

275 Selection of Books and Materials for Young Adults. *Prerequisite:* EDLS 272 or equivalent. Three hours.

276 Reference Sources and Services. *Prerequisite:* EDLS 274. Three hours.

277 Library Materials and Services for Media Personnel. *Prerequisites:* EDLS 272, 273. Three hours.

278 Cataloging and Organization of Media Materials. *Prerequisite:* EDLS 273.

279 Selection of Library Materials for Children. *Prerequisite:* EDLS 272 or equivalent. Three hours.

EDHS—HUMAN SERVICES

209 Introduction to Research Methods in Education and Social Services. Seminars and research projects will introduce the students to the methods of historical, descriptive, experimental, quasi-experimental, field studies, and survey research. Three hours.

258 Community Organizations and Resources. Introduction to the range of clients served by Human Service Agencies and response patterns typically initiated. Survey of facilities and services available. *Prerequisite:* Permission of instructor. Three hours.

291 Special Topics in Organizational and Human Resource Development. Special issues in counseling, administration and planning, social work, or higher education not appropriate to content of existing courses. Reflects social services orientation of OCFS. Variable hours.

366 Social Welfare and Social Work as Social Institutions. Critical survey of the philosophy and purpose of social welfare and systems of service delivery in welfare agencies. Investigation of basic concepts of social work practice. Three hours.

EDSP—SPECIAL EDUCATION

201 Foundations of Special Education. Examination of historical, current trends in the treatment of handicapped individuals, including the effects of litigation, legislation and economic considerations on educational and residential service delivery systems. *Prerequisite:* Twelve hours in education and related areas, or permission of instructor. Three hours.

207 Cooperative Learning. Theoretical and experiential instruction in procedures to increase social acceptance and academic achievement of exceptional learners in mainstream settings through cooperative learning is provided. *Prerequisites:* Permission of instructor. Three hours.

216 Instruction for Mildly Handicapped Individuals. Introduction to curriculum for instruction of children with learning disabilities, mental retardation, behavior disorders. Emphasis on objectives, assessment, task analysis, curriculum and evaluation *Prerequisite:* Permission of instructor. Three hours.

217 Instruction for Severely Handicapped Individuals. Individualized instruction for severely handicapped learners with emphasis on objectives, assessment, task analysis, curriculum and evaluation is provided. *Prerequisite:* Permission of instructor. Three hours.

224 Instruction for Mildy Handicapped Individuals. Students apply principles of behavior analysis to improve academic and social skills of individuals with learning disabilities, mental retardation and behavior disorders. *Prerequisite:* Permission of instructor. Three hours.

228 Instruction for Severely Handicapped Individuals. Students apply advanced principles of behavior analysis to improve skills in learners severely handicapped in motor, social, communication or self-care areas. *Prerequisite:* Permission of instructor. Three hours.

275 Developing Vocational Instruction for Students with Special Needs. (See Voc. Ed. & Tech. 275.)

290 Curriculum For Handicapped Individuals. Intensive study of curriculum aspects constituting basic skills, knowledge to be learned at a given instructional level. Instructional objectives. Development of evaluation system to measure each learner's achievement. *Prerequisite:* Permission of instructor. Three hours.

296 Special Education Practica for Classroom Teachers. Credit as arranged.

297 Curriculum for Handicapped Individuals. Students develop and implement an objectives-based curriculum for learners with learning disabilities, mental retardation, behavior disorders and/or multi-

handicaps. *Prerequisite:* Permission of instructor.

298 Special Education Practicum. Students provide direct instruction for six learners with learning disabilities, mental retardation, behavior disorders and/or multi-handicaps. *Prerequisite:* Permission of instructor. Credit as arranged.

301 History and Systems of Services for Handicapped Individuals. Historical and current trends in treatment of handicapped individuals, including effects of litigation, legislation, economic consideration in education, vocational, residential service delivery systems. *Prerequisite:* Acceptance as candidate for M.Ed. degree in special education, or permission of instructor. Three hours.

302 Physical and Developmental Characteristics of Individuals with Multi-Handicaps. Normal development — birth through six years, developmental disorders, handicapping conditions. Medical, health considerations for multi-handicapped. Management of multi-handicapped learner through employment of appropriate handling, positioning, feeding, toileting procedures. *Prerequisite:* Permission of instructor. Three hours.

310, 311 Curriculum and Technology in Special Education. Curricular areas essential to education of secondary level handicapped students. Development, adaptation of curricula in reading, mathematics, written expression, social skills, career development, vocational skills, learning strategies. *Prerequisite:* Permission of instructor. Cross listings: VOTC 310, 311. Three hours.

312, 313 Advanced Behavior Principles in Special Education. A survey on behavior theory and research applications for learners with learning disabilities, mental retardation, behavior disorders and multi-handicaps. *Prerequisite:* Permission of instructor. Three hours.

316 Research Seminar in Special Education. Rsearch which addresses key issues in special education is reviewed and evaluated. Students write and present a research review with attention to practitioner needs. *Prerequisites:* EDSP 301, 310, 312 and a course in quantitative research design. Three hours.

317 Design and Evaluation of Education for Severely Handicapped Individuals. Students analyze, adapt curricula for severely handicapped, utilizing knowledge of normal, abnormal motor development, feeding techniques, adaptive, prosthetic devices, medial aspects, parent professional partnership, socialization, normalization, legal aspects. *Prerequisite:* Permission of instructor. Three hours.

319 Internship for Specialized Personnel in Education. Approved internship reflecting student's interest and needs. Competency-based instruction in development, implementation of effective programs for learners eligible for special education services. *Prerequisite:* Permission of instructor. Credit as arranged.

320 Laboratory Experience in Education: Educational Programming for the Severely Handicapped. Students identify, evaluate severely handicapped learners, demonstrate competency in handling, positioning, feeding. Current skill levels assessed, educational programs designed, including objectives, teaching/learning procedures, evaluation, measurement. *Prerequisites:* Master's Degree or equivalent and permission of instructor. Three hours.

322 Internship in Special Education: The Triadic Model of Consultation. Competency-based instruction in oral and written communication, consultation and workshop level training is provided. Students apply the consultation model in an educational setting. *Prerequisites:* EDSP 310, 312 or permission of instructor. Three hours.

323 Internship in Special Education: Systems Development. Competency based instruction in planning for system level development and change is provided. Students apply systems theory in an educational setting. *Prerequisites:* EDSP 310, 312 or permission of instructor. Three hours.

384 Teaching-Internship in Special Education: Course Development and Implementation. Instruction in developing competency-based courses in special education for inservice teacher training is provided. Practicum involves team teaching with University special education faculty. *Prerequisites:* Certification as a Consulting Teacher/Learning Specialist and permission of instructor. Six hours.

385 Teaching Internship: Advanced Systems Development and Management in Special Education. Competency-based instruction in developing and adapting technological programs for system-level change is provided. *Prerequisite:* EDSP 319 (6 hours) and permission of instructor. Three to six hours.

386 Teaching Internship: Management of Learning Environments for the Handicapped. Implementation of data-based individualized education in one-to-one, small group and large group instruction for severely handicapped student(s) in special or regular classrooms. *Prerequisites:* EDSP 217, 290, 228 or permission of instructor. Variable credit.

EDAP — Administration & Planning

264 Evaluation in Education and Social Services. For educational and social service personnel. Overview of the state-of-the-art of evalution, emerging concepts, related models. Potential applications to settings; systematic data analysis. *Prerequisite:* Twelve hours in education or permission of instructor. Three hours.

266 Educational Finance. National and State statutes, practices in Educational Finance and Taxation; local practices in taxation; other revenue sources; methods for school budgeting; financial expenditure procedures. *Prerequisite:* Twelve hours in education or permission of instructor. Two-three hours.

268 Educational Law. Legal basis for Education. State and Federal statutes; related court cases: Attorney General opinions; Special Education procedures; Vermont State Board and State Education Department policies; regulations. *Prerequisite:* Twelve hours in education or permission of instructor. Two-three hours.

280 School Business Management. An analysis of the basic concepts which provide the foundation for school business operations. Topics include finance, facilities, logistical and classified personnel administration. *Prerequisite:* Twelve hours in Education. Three hours.

291 Special Topics in Organizational and Human Resource Development. Special issues in counseling, administration and planning, social work, or higher education not appropriate to content of existing courses. Courses will reflect the social services orientation of OCFS. Variable hours.

332 Seminar in Administration and Planning. Opportunity for students to experience, apply selected administration and planning concepts, skills through seminar and selected simulations of public school and social service organizational settings. Three hours.

335 Staff Evaluation and Development. Supervisory roles, behavior, responsibilities, and relationships in educational and social service organizations; processes for evaluating the performance and promoting the development of staff, and increasing organization effectiveness. Three hours.

337 Political Processes in Education and Social Service Organizations. Political and operational relationships of organizations to multiple publics and governmental bodies at the local, state, and national levels. Three hours.

352 Analysis of Educational and Social Service Organizations. Organizations and open or closed systems; examinations of goals, power, conflict, leadership, decision-making, roles, communication; diagnosing causes of organizational problems; factors aiding, impeding organizational change. Three hours.

353 Seminar in Organizational Leadership. Administrative roles, functions, and responsibilities in maintaining and changing organizations; hierarchial relationships; leadership styles and behavior appropriate for managing in contemporary and future organizations. Three hours.

354 General and Social Systems Theory. General Systems Theory is analyzed in terms of its utility for examining social systems, macro-systems analysis of research, planning, and interdisciplinary dialogue. Three hours.

355 System Analysis and Planning. An analysis of and experience with planning theories and techniques that derive from General Systems Theory. Three hours.

356, 357 Seminar in Futurism and Planning. Knowledge, values, attitudes relating to concept of the future; alternative futures, tread analysis, goal setting; planning processes applied to educational and

social service organizations. Six hours (each semester can be taken independently).

358 Seminar in Community Education. The seminar participants will analyze the Community Education process, relate the process to community development, and develop strategies for the planning and implementation of Community Education. Three hours.

367 Human Behavior in Education Systems. This course will enable students in the Doctorate in Education program to understand and assess human behavior as it affects and is affected by education systems. *Prerequisite:* Graduate standing, Ed.D. students have priority. Three hours.

369 Ethics in Educational and Social Services Administration. Critical examination of theories of ethical decision making. Implications for leadership in educational, social service settings. Ethical investigation utilizing research, scholarship, actual incidents, case studies, role playing. *Prerequisite:* Graduate standing, Ed.D. students have priority. Three hours.

372 Leadership and the Creative Imagination. Leadership in societal organizations as presented in literature, other media. Students will demonstrate abilities to integrate leadership theory, principles, personal beliefs, practices with literary and other media models. *Prerequisite:* Graduate standing, Ed.D. students have priority. Three hours.

386 Organization and Human Resource Development. The concept and practice of organization development, analysis of and laboratory experience in the utilization of intervention methodologies. *Prerequisite:* One course relating to human relations and one course relating to organizations or equivalent (e.g., 220, 332, 352, 353, 355, 374, 383), or permission of instructor. Three hours.

409 Applied Educational Research. This course links educational research methodology with principles of systems change in order to provide a knowledge base for conducting applied educational research. *Prerequisites:* EDFS 209 or equivalent, doctoral level standing. Three hours.

432 Seminar in Small Systems Administration and Planning. This course is designed to familiarize participants with knowledge and research relevant to developing an applied theory of action for administering small rural educational systems. *Prerequisite:* Doctoral level standing. Three hours.

437 Seminar on Education Policy. An examination of the nature and function of education policy, with emphasis on the structure and processes in education policy formulation and implementation. *Prerequisite:* Doctoral level standing. Three hours.

491 Doctoral Dissertation Research. Credit as arranged.

EDHI — Higher Education

291 Special Topics in Organizational and Human Resource Development. Special issues in counseling, administration and planning, social work, higher education not appropriate to content of existing courses. Courses will reflect the social services orientation of OCFS. Variable credit.

360 Higher Education in America. Critical, contemporary overview of the American university in crisis, from perspectives of differing value positions. Implications of conflicting value philosophies for theory, practice of higher education. Three hours.

362 The American College Student. Study of the American college student within his living-learning environment. Emphasis upon sociological and psychological aspects in relation to student personnel work and counseling. *Prerequisite:* Twelve hours in education, psychology, and sociology or related areas. Three hours.

383 Higher Education Administration and Organization. Introduction to concepts of administration and organization as applied to contemporary higher education setting. Characteristics of organizations, dynamic elements of administration and theories and processes of change. *Prerequisite:* Permission of instructor. Three credit hours. Holmes, Young.

385 Student Development in Higher Education. Purposes, organization, administration of student personnel services in higher education. General practices, current research, future trends within human development framework. Role, objectives, philosophical assumptions of student development education. Three hours.

387 Seminar in Higher Education. Designed for graduate students concentrating in programs in Higher Education. Analysis and discussion of current issues and problems in higher education. *Prerequisite:* Permission of instructor. One to three hours.

EDCO—Counseling

220 Personality Development. Approaches to understanding human behavior in applied settings. With emphasis on behavior development as an interpersonal process. *Prerequisite:* Twelve hours in education and psychology. Three hours.

274 Counseling Theory and Practice. Theoretical and practical approach to understanding dynamics of the counseling process. Refinement of personal philosophy, theory of counseling, and implementation in practice. *Prerequisites:* Graduate standing, twelve hours in education and/or psychology, and permission of instructor.

291 Special Topics in Counselor Education. Special issues in counseling, administration and planning, social work, higher education not appropriate to content of existing courses. Courses will reflect the social services orientation of OCFS. Variable credit.

293 Group Dynamics: Theory and Experience. Encounter group experiences for prospective counselors providing increased awareness of self and of modes of relating to others. Theory, practice of group dynamics. *Prerequisites:* Twelve hours in education and psychology and permission of instructor. Three credits.

295 Laboratory Experience in Counseling. Supervised practice in counseling techniques. Students develop skills and receive feedback. Use is made of videotape facilities. *Prerequisites:* Counseling majors only, concurrently enrolled in EDCO 274 or consent of instructor. Three hours.

321 Consultation Skills. The consultation relationship in educational and Social Service settings. *Prerequisites:* EDCO 220, permission of instructor. Three hours.

350 Foundations of the Helping Process. Critical analysis of the various facets of counseling within the current cultural setting. Special emphasis upon goals of the helping process and their justification. *Prerequisite:* Twelve hours in education and psychology. Three hours.

351 Using Tests in Counseling. Techniques used to explore the psychology of individual differences and group assessment. Experience given in talking, administering, interpreting various tests: study project for application to any setting. *Prerequisite:* Twelve hours in education. Three hours.

368 Life Style Appraisal. Technique for developing, understanding an individual's subjective method of perceiving life events. Applications of the technique in various counseling modalities. Practice in use of technique. *Prerequisites:* EDOH 220, 374, and permission of instructor. Three hours.

370 Elementary School Guidance. Development of elementary school counseling programs. Techniques appropriate to such settings: classroom discussions, parent education, teacher consultation, appraisal techniques, etc. Enhancing development of positive self-concept. *Prerequisites:* 220 and 350. Three hours.

381 Counseling for Career Development. Psychology of career development with emphasis upon counseling for career decision-making within the current cultural context. *Prerequisite:* Graduate standing. Three hours.

384 Practicum in Counseling. Supervised experiences in individual and small-group counseling situations. Minimum of 30 hours in actual counseling relationships. Analysis, evaluation of verbatim samplings. For students nearing completion of degree. *Prerequisites:* 374 and permission of instructor. Three hours.

386 Organizational and Human Resource Development Program. The concept and practice of organization development, analysis of and laboratory experience in the utilization of intervention methodologies. *Prerequisite:* Permission of instructor. Three hours.

388 Procedures in Family Counseling. Theory and process of counseling with families. Live demonstrations of family counseling with opportunities for student involvement. *Prerequisites:* EDOH 220, EDOH 374, and permission of instructor. Three hours.

389 Advanced Practicum in Family

Counseling. Supervised practice in family counseling. *Prerequisites:* EDOH 388, permission of instructor.

390 Advanced Counseling Seminar. Analysis and practice of advanced counseling skills with focus on new developments. Emphasis on integration of theory and technique into a consistent counseling model. *Prerequisites:* EDCO 274, 295, 384, and consent of instructor. Three credit hours. Peterson.

393 Advanced Study in the Theory and Practice of Group Counseling. Advanced study of group counseling theory as it applies to group establishment and intervention strategies. A field experience in group counseling is required. Three hours.

OTHER COURSES IN EDUCATION

In addition to the courses previously described, the following courses are also offered, usually in the Summer Session and Evening Division.

209	Education of Teachers of the Mentally Retarded I—Early Years	3-6
210	Education of Teachers of the Mentally Retarded II—Later Years	3-6
214	The Slow Learner (Education of the Exceptional Child)	3-6
215	The Gifted Child	3
219	Workshop in Economic Education	1-4
250	Foundations of Rehabilitation	3
251	Case Management in Rehabilitation	3
260	Vocational Development and Placement Processes	3
261	Seminar in Business Education	3
282	Seminar for Prospective Teachers of English	3
291	Psychology of Music	3
305	Medical Information for Counselors	3
373	Individual Testing	3

ELECTRICAL ENGINEERING

Professors Absher, Anderson, Evering (Chairperson), Handelsman (Emeritus), Lai, Mirchandani, Roth, Rush, and Williams; Adjunct Associate Professors El Kareh, Koss, and Rideout; Adjunct Lecturers Chappelow, King and Rogers. Associate Professor Bowman; Assistant Professor Titcomb.

Master of Science and Doctor of Philosophy programs are offered. Candidates normally have obtained the Bachelor of Science degree in Electrical Engineering prior to application for admission but other applicants are encouraged to consider the program if they have extensive background in mathematics and the basic sciences. In such cases, it may be necessary for a student to complete his/her entrance qualifications without receiving credit toward his/her graduate studies. The general requirements for admission as outlined under the "Regulations of the Graduate College" must be met. Areas of research interests are control systems, biomedical engineering, electromagnetic fields, instrumentation, solid state physical electronics, information processing, pattern recognition and communication theory, semiconductor materials, devices and integrated circuits.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An accredited bachelor's degree in an appropriate field.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

An accredited bachelor's degree in Electrical Engineering or equivalent education.

MINIMUM DEGREE REQUIREMENTS

Advanced courses in electrical engineering, physics, and mathematics (18-24 hours) with at least 15 credit hours appropriately distributed in approved areas of study in the Computer Science and Electrical Engineering Department; thesis research (six-12 hours).

Although a thesis is normally required in the program leading to the M.S. in Electrical Engineering, the thesis may be waived, with departmental approval in favor of additional courses. In such cases, the student will be expected to have substantive professional experience, or to submit high quality technical reports as evidence of professional maturity.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

An accredited master's degree in Electrical Engineering or the equivalent.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Successful completion of Ph.D. comprehensive examinations. The majority of students will have completed the core program — comprising graduate courses in controls, fields, solid state circuits, communications, mathematics, and physics — before taking the comprehensive examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

At least 42 credit hours in courses and seminars and 30 credit hours in dissertation. Normally, 12 additional credit hours in an area of specialization are found necessary. The language requirement for the Electrical Engineering Ph.D. program is comprised of the following: satisfactory passing of a reading proficiency examination in one foreign language. The selection typically shall be made from French, German, Japanese, or Russian. The requirements specified under the Regulations of the Graduate College must also be met.

COURSES OFFERED

201 Linear System Theory (3-0). Analysis of systems, application to problems in electrical engineering. Modeling, analysis of discrete and continuous-time linear systems. Continuous, discrete time Fourier transforms. Approximation, model reduction using state-space methods. *Prerequisite:* Graduate standing in Electrical Engineering or permission of instructor. Three hours. Mirchandani.

202 Network Analysis (3-0). Computational methods for analysis of linear, nonlinear circuits. Emphasis on large-scale circuits. State variable, modified nodal; sparse tableau formulations. Transistor

modeling for D.C., transient, steady-state analysis. Determination of sensitivity. *Prerequisites:* 171, Math 124 or equivalent background. Three hours. Mirchandani.

209 Transient Phenomena (3-0). Complex variable basis of Laplace and Fourier Transforms; applications to transient behavior of lumped and distributed parameter systems, root locus. Nyquist criterion, two-dimensional field problems. *Prerequisite:* 4. Three hours. Rush.

220 Electronic Instrumentation for Scientists (3-3). Electrical components, circuit theory, electrical measurements, oscilloscopes, power supplies, amplification, oscillators, measurements, servos, operational amplifiers, electronic switching, timing, digital counting circuits. No credit for students in Electrical Engineering. *Prerequisites:* College physics, calculus or permission of instructor. Four hours.

231, 232 Digital Computer Design. Hardware components, design, organization, realization. Design concepts, procedures, design of small computer. Microprogrammed control units, memory organization, hardware realization of high-speed arithmetic operations. Interrupt, I/O systems, interfacing, inter-system communications. *Prerequisite:* Departmental permission. Three hours. Absher, Lai.

233, 234 Microprocessor-Based Systems and Applications (2-3). Basic principles of mini/microcomputers; A/D; D/A; channels, magnetic devices, display devices, mechanical devices; interface designs of analog systems to mini/microcomputers; principles of microprogramming; bit-slice-based microcomputers. *Prerequisite:* Departmental permission, Computer Science 101 desirable, 233 for 234. Three hours. Williams.

238 Computer Applications to Design and Manufacturing (3-0). Basic and advanced high level program languages and applications. *Prerequisite:* Departmental permission. Three hours.

239 Computer Assisted Design (2-0). Circuit design, modeling and analysis via visual display computer terminals. Use of ASTAP system to analyze device characteristics and diffusion parameters. *Prerequisites:* 261 and departmental permission. Two hours.

240 Boundary Value Problems in Electromagnetism (3-0). Problems of Electromagnetism emphasizing Helmholtz' theorem, uniqueness theorems and numerical methods. *Prerequisite:* 141. Three hours. Rush.

242 Theory and Applications of Time-Varying Fields (3-0). Maxwell's equations and boundary conditions for time varying systems. Propagation and reflection of electromagnetic waves, guided electromagnetic waves, and antennas. *Prerequisite:* 240 or departmental permission. Three hours.

261 Semiconductor Devices and Materials I (3-0). Energy band theory, effective mass concept. Band structure effect on electronic properties of semiconductors. Transport of electrons; holes in bulk materials, across potential barriers. Homojunctions, heterojunctions, Schottky barriers. *Prerequisite:* Physics 128. Three hours. Anderson.

262 Semiconductor Devices and Materials II (3-0). Operating principles of bipolar junction transistors and field effect transistors. Derivation of equivalent circuits. Applications to integrated circuits, charge-transfer devices, integrated injection logic. *Prerequisite:* 261. Three hours. Anderson.

266 Science and Technology of Integrated Circuits. Science and technology of silicon monolithic integrated circuit processing and interactions of the processing steps with the electrical circuit properties are investigated. *Prerequisite:* 163 or 261 and concurrent registration in 164 or 262. Three hours.

270 Signal Analysis (3-0). General signal concepts. Random signals. Correlation techniques. Noise in linear systems. Wiener and Kalman filters for data smoothing and prediction. Spectral estimation. *Prerequisite:* 171 or equivalent. Three hours. Lai.

271 Signal Processing: Detection and Estimation (3-0). Principles of detection, estimation. Detection of signals in noise. Estimation of signal waveforms, signal spectra. Wiener, Kalman filters. Applications to communication, radar systems, pattern recognition, biomedical signal analysis. *Prerequisite:* 270. Three hours. Lai.

275 Analog Signal Processing and Filtering (3- 0). Introductory filter concepts. Approximation techniques. Filter realizations.

Design of practical filters. Switched capacitor filters. A/D and D/A converters. Processing and filtering of real-world signals. *Prerequisite:* 201 or 171 and 172 or equivalent. Three hours. Lai, Mirchandani.

276 Digital Signal Processing and Filtering (3- 0). Introductory digital signal concepts. Structure of digital filters. Design of digital filters. Use of FFT in signal processing and filtering. Hardware implementation. Applications to signal processing and filtering. *Prerequisite:* 275. Three hours. Lai, Mirchandani.

277 Advanced Topics in Digital Signal Processing and Filtering (3-0). Approximation methods in design of digital filters. Effect of finite word length. Two-dimensional signal sampling, transforms and digital filters. Hardware implementation. Application in signal processing. *Prerequisite:* 276. Three hours. Lai, Mirchandani.

281 through 284 Seminars (1-0). Presentation and discussion of advanced electrical engineering problems and current developments. *Prerequisite:* Senior or graduate engineering enrollment. One hour.

285 Creative Engineering (3-0). Creative techniques applied to problems in process control, biomedical engineering, communications, circuit design. *Prerequisite:* Graduate standing in Electrical Engineering or departmental permission. Three hours.

295 Special Topics. Formulation and solution of theoretical and practical problems dealing with electrical circuits, apparatus, machines or systems. *Prerequisite:* 4. Three hours.

311, 312 Introduction to Optimum Control Systems. Review of conventional design methods. Introduction to optimal control problem formulation and solution; including the calculus of variations, Pontryagin's maximum principle, Hamilton-Jacobi theory, Dynamic Programming, and other computational methods. *Prerequisites:* 110; 311 for 312. Three hours. Absher.

314, 315 Nonlinear System Theory. Basic nonlinear methods including computational and geometrical techniques for analysis of nonlinear systems. Describing function methods and bifurcation and catastrophe theory. Sensitivity and stability considerations. *Prerequisite:* 201 or Mathematics 230. Three hours. Mirchandani.

340, 341 Special Topics in Electromagnetic Field Theory. For advanced students in the field of electromagnetism. Topics selected from special interests of staff with lectures and readings from current literature. Three hours.

365 Optical Properties of Solids. Optical and optoelectronic properties of semiconductors. Applications to photodetectors, solar cells, light emitting diodes and lasers. *Prerequisites:* 262, 242, Physics 273. Three hours. Anderson.

373, 374 Digital Communication (3-0, 3-0). Modulation and coding in digital communication systems. Baseband pulse transmission. Linear modulation systems. Digital FM and PM. Error-correcting codes: block codes and convolution codes. Applications. *Prerequisites:* Graduate standing in Electrical Engineering or 174; 373 for 374. Three hours. Lai.

366 Solid State and Semiconductor Theory I (3-0). Energy band theory for electrons and phonons in crystalline solids. Brillouin zones. Conservation laws. Elements of statistical mechanics. Transport properties. Applications to semiconductor electronics. *Prerequisites:* 261 and Physics 273 or Chemistry 263. Three hours. Anderson.

378 Special Topics in Statistical Communication and Related Fields. Coding for communication or computer systems, pattern recognition and learning machines, artificial intelligence, etc., selected from special interests of staff with lectures and readings from current literature. *Prerequisite:* Graduate standing in Electrical Engineering. Three hours. Lai.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

The following courses are offered infrequently but may be taught where sufficient student interest is demonstrated.

235, 236 Hybrid Computers. Three hours.

237 Digital Computer Logic, Circuits and Systems. Three hours.

251 Applications of Linear Algebra. Three hours.

272 Information Theory. Three hours.

317, 318 Theory of Optimum Control Systems. Three hours.

319, 320 Special Topics in Control System Theory. Three hours.

345 Electromagnetic Antennas and Propagation. Three hours.

367 Solid State and Semiconductor Theory II. Three hours.

ENGINEERING PHYSICS

A program of advanced study in physics and engineering to prepare students for research and development positions in mission-oriented organizations. Advanced courses in both physics and engineering are required as is a comprehensive examination and a thesis based upon the application of physical principles to a real or simulated engineering problem. A non-thesis option is available to students who have already demonstrated ability to perform research and report the results in written and oral form.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Students with an accredited bachelor's degree in computer science, engineering, applied mathematics, or physics are normally considered for admission to the program. Submission of scores on the general (aptitude) Graduate Record Examination is required.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

The student is expected to have completed the courses required for the B.S. in Engineering Physics at the University of Vermont. These include Math 271, 272 (applied Mathematics), ME 50 or Physics 211 (intermediate mechanics), ME 101 (materials engineering), Physics 265, ME 41, or ME 115 (thermal science), Physics 213, 214 or EE 143, 144 (electromagnetism), Physics 273 (quantum mechanics), Physics 242 or EE 263, 264 (solid state physics).

Since these are prerequisites to the degree program, and not the program itself, any of these course prerequisites may be placed by a demonstration of equivalent knowledge of their content, to the satisfaction of the Studies Committee.

Demonstrated ability to program scientific or technical problems in Fortran, APL, or an equivalent language.

MINIMUM DEGREE REQUIREMENTS

Thesis option

Completion of 30 credits of study approved by the Studies Committee, which must include Physics 341, 342, and 362, not fewer than six credits in graduate engineering courses, and six credits in Physics 391 (Thesis research). This option requires submission of a thesis based on an independent investigation demanding the application of physical principles to a real or simulated engineering problem approved by the Studies Committee.

Non-thesis Option
Students who are offered the non-thesis option must elect to replace the requirement of Physics 391 with Physics 381, 382.

Examinations
All students are required to pass the regularly offered Physics Comprehensive Examination, administered annually *circa* the end of May. Students submitting a thesis (Physics 391) must pass the usual Thesis Examination.

ENGLISH

Professors Bradley, Broughton, Clark (Chairperson), Cochran, Eschholz, Howe, Huddle, Jones, Long, Orth, Poger, Rosa, Rothwell, and Shepherd; Associate Professors Dickerson, Edwards, Gutman, Hall, Stanton (Director of Graduate Studies), Stephany, and Thompson; Assistant Professors Biddle, Simone, and Sweterlitsch.

The research interests of the faculty of the Department of English and library resources permit graduate students to undertake thesis subjects in virtually all the fields of the discipline.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS

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

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

If admitted conditionally, the student must complete satisfactorily a stipulated number of hours (usually six) of graduate level work for advancement to candidacy for the master's degree.

MINIMUM DEGREE REQUIREMENTS

The department also offers a program leading to the degree of Master of Arts in Teaching: See p. 49.

For MA and MAT: Eighteen hours in English, including 302; 311 and 318, and six additional hours in English or a related field. Also for MA: 371; six hours of thesis research; and reading knowledge of a foreign language, normally French or German.

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

At the 200 level, the Department of English offers several seminars each semester which are numbered as described below. The specified topics vary each semester,

depending on the instructors assigned. However, over the normal course of a graduate student's program, every member of the department's graduate faculty will offer a seminar in his/her area of special interest and expertise.

201, 202 Seminar in Language, Criticism or Rhetoric.

211, 212 Seminar in British Literature to 1660.

221, 222 Seminar in British Literature, 1660-1900.

231, 232 Seminar in Modern British Literature.

241, 242 Seminar in American Literature to 1900.

251, 252 Seminar in Modern American Literature.

261, 262 Seminar in Literary Themes, Genres or Folklore.

282 Seminar for Prospective Teachers of English. Grammar and language; literary interpretation and criticism; allied problems useful to teachers of English. Three hours. Biddle.

301 Structure of the English Language. A descriptive study of Modern American English. Three hours. Clark.

302 Graduate Seminar. Graduate students only. Topic varies from semester to semester, depending on faculty member assigned to the course. One seminar is required of all graduate students in English. Three hours.

303-304 Problems and Research in Teaching Secondary School English. Consideration of problems, curricular materials, teaching procedures and research methods in secondary school language, literature, and composition. *Prerequisites:* Twelve hours of education; acceptance as qualified to earn graduate credit in English. Three hours. Biddle.

311 Chaucer. Study of the principal works of Chaucer, with emphasis on Chaucer's literary scope, talents, and position in medieval literature. Three hours. A.I. Dickerson; Stephany.

318 Milton. Study of *Paradise Lost, Paradise Regained, Samson Agonistes,* minor poems, and selected prose works. Three hours.

371 Principles of Literary Research. Methods of literary study, research, and scholarship. Required of all MA candidates in English. Three hours. Orth, Stanton.

391 Master's Thesis Research. Credit as arranged.

397, 398 Special Readings and Research. Directed individual study of areas not appropriately covered by existing courses. Not to exceed three hours per semester.

EXTRA-DEPARTMENTAL COURSES (See Page 175)

FORESTRY

For description of the M.S. Program in Forestry, see NATURAL RESOURCES, page 144.

FRENCH

Associate Professors Carrard, Crichfield, T. Geno, and Whatley (Chairperson); Assistant Professors Senecal, Van Slyke, Whitebook, and Wiley-Sandler; Lecturer M. Geno.

Opportunities for thesis research in French literature are offered in all areas from the medieval through the 20th century, as well as French-Canadian literature and African literature of French expression.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS

An undergraduate major in French or equivalent. Satisfactory scores on the general (aptitude) and subject (advanced) Graduate Record Examinations.

MINIMUM DEGREE REQUIREMENTS

Twenty-four hours in French, which may include six hours in a related field, and in addition:

Plan A: Thesis research (six hours)

Plan B: In lieu of a thesis the candidate may write a series of master's essays with variable credit of up to three credits per paper (six hours).

A program is also offered leading to the degree of Master of Arts in Teaching. Satisfactory scores on the Graduate Record Examinations general and subject (Aptitude and Advanced) are requirements for admission to graduate studies for the M.A.T.

COURSES OFFERED

The following courses are available for graduate credit. They are divided into courses concerned primarily with advanced language study and those which treat literature. In literature, the 200 level courses, open to both undergraduates and graduates, cover the history of French literature from its origins to the present time by means of division into centuries and genres. Emphasis is placed on major figures and works, with a view to studying them for their intrinsic value as well as in their historical context. For more detailed information on specific courses, consult with department chairperson and the course instructor.

FRENCH LANGUAGE

209 Advanced Grammar. Comparative grammatical study centered on the specific problems encountered by Anglophones in written and spoken French. Three hours. M. Geno.

210 Romance Philology. Development of French, Spanish, and Italian from Latin. Study of documents. *Prerequisite:* Intermediate level in at least two of the languages, or permission. Taught in English. Three hours. Whitebook. Alternate years, Spring 1985.

215 Methods of Text Analysis. Introduction to procedures and terminology used in analysis of texts of various genres. Three hours. Carrard.

216 Stylistics. Study of idiomatic difficulties faced by people who learn French; translation; analysis of the various "levels of speech" in French, with their stylistic features. Three hours. Carrard.

French Literature and Civilization

225 Medieval French Literature. First semester: Old French Language; 12th century epics, e.g. *La Chanson de Roland, Le Pelerinage de Charlemagne,* Breton lays; Marie de France. Three hours. Whitebook. Alternate years, 1983-84.

226 Medieval French Literature. Second semester: Romances: Chretien de Troyes, Guillaume de Lorris and Jean de Meung; lyric poetry, Machaut; Pisan; Charles d'Orleans; farces and miracles. *Prerequisite:* 225. Three hours. Whitebook. Alternate years, 1985-86.

235 16th Century France: A World in Transition. Focuses on literary, esthetic, and cultural aspects of the 16th century, a pivotal era between medieval and modern societies. Three hours. Wiley-Sandler. Alternate years, 1983-84.

236 The Developing Renaissance in France. The Renaissance as a cultural and esthetic phenomenon in the years 1530-1560, its changing influence on French thought and culture. Three hours. Wiley-Sandler. Alternate years, 1985-86.

245 The Baroque Age, 1600-1650. The literature after France's civil wars, up to the triumph of classicism: religious, lyric, and political poetry; idealistic, picaresque and fantastic novels; baroque drama; Pascal. Three hours. Whatley. Alternate years, 1984-85.

246 17th Century. Selected works of the Century with emphasis on Corneille, Racine and Moliere. Three hours. Whatley. Alternate years, 1984-85.

255 18th Century Literature. Writers of the early Enlightenment. Possible topics: the impact of the new science; the literary reflection of new social types; the "pursuit of happiness." Three hours. Whatley. Alternate years, 1983-84.

256 18th Century Literature. Rousseau, Diderot, Laclos, Sade: the generation before the Revolution. Possible topics: the attempts to define "natural man;" the relationship between the arts and morality, between *liberty* and *libertinism*. Three hours. Whatley. Alternate years, 1983-84.

265 The Romantic Period. Major figures and themes of the Romantic movement, including Chateaubriand, Madame de Stael, Hugo, Balzac, Stendhal, Musset. Possible topics: the revolt against Classicism, the Romantic view of nature, *le vague des passions*. Three hours. Crichfield. Alternate years, 1983-84.

266 The Second Empire Through 1900. The rise of modern literary realism, Naturalism, Symbolist poetry, Decadence. Authors include Flaubert, Zola, Maupassant, Baudelaire, Verlaine, Rimbaud, Mallarme, Huysmans. Three hours. Crichfield. Alternate years, 1983-84.

275, 276 Twentieth Century Literature. Selected topics dealing with poetry and/or narrative related either to an historical period or a literary movement. Three hours. Carrard. Alternate years, 1984-85.

277 Topics in 20th Century French Theatre. Subjects may include: *le theatre traditionnel, le theatre "de l'absurde", le theatre de la marge,* a combination of all the above. Each may be repeated up to six hours. Three hours. T. Geno. Alternate years, 1983-84.

285 French Canadian Literature. Study of fiction and poetry from 1835 to 1940. Three hours. Senecal. Alternate years, 1984-85.

286 French Canadian Literature. A continuation of 285, encompassing fiction, poetry and theatre from 1940 to 1975. Three hours. Senecal. Alternate years, 1984-85.

289 African Literature of French Expression. Study of West African poetry, theatre, novel, and civilization as an expression of the Black experience in the language of the French colonizer. Three hours. T. Geno. Alternate years, 1984-85.

291 Civilization of France. A study of the evolution of French institutions in their geographic, political, social, economic and intellectual contexts from the Middle Ages to the Second World War. Three hours. M. Geno.

292 Contemporary Civilization of France. A study of French institutions and daily life since the Second World War, with an emphasis on the most recent changes. (French 291 or History 53 or 153 strongly recommended.) Alternate years, fall 1984. Three hours. M. Geno.

293 French Canadian Civilization. Sociocultural study of the French civilization of Canada. Three hours. Senecal. Alternate years, 1983-84.

295, 296 Advanced Special Topics

297, 298 Advanced Readings and Research

391 Master's Thesis Research. Credit as arranged.

GEOGRAPHY

Professors Gade, Miles, and VanderMeer (Chairperson); Associate Professors Barnum, Lind, and Meeks; Assistant Professors Bodman and Ryerson; Visiting Assistant Professor Howland.

Faculty research interests include most systematic aspects of geography, especially from an historical perspective. Technique interests are in cartography, remote sensing, and quantitative methods. Regional interests and field experiences are almost world-wide in scope.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS

Evidence of a strong interest in geography. Satisfactory scores on the general (verbal and quantitative) portion of the Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Twelve semester hours or its equivalent in geography and supporting courses in related fields or demonstrated proficiency in geography which would be assurance of success in graduate study.

MINIMUM DEGREE REQUIREMENTS

Twenty-one hours in geography courses at the 200 and 300 level, including Geography 201, including Geography 287 or a reading knowledge of a foreign language, and including up to six hours in Geography 391; nine additional hours at the 200 and 300 level in geography and/or related fields; a satisfactory thesis. For additional information, please write to the Graduate Program Coordinator, Department of Geography.

The Department also offers a program leading to the degree of Master of Arts in Teaching: see p. 49 for M.A.T.

COURSES OFFERED

Admission to the following courses for graduate credit requires the approval of the Graduate Program Coordinator in geography.

201 Perspectives on Geography. Geographic concepts and research methodology; the formulation, conduct, and presentation of a research effort. Three hours.

210 Special Topics in Regional Geography. Specialized study of a particular region. *Prerequisite:* Permission of instructor. Three hours.

216 Biogeography. Processes and patterns of distribution, domestication, and human utility of plant and animal species and communities in varying environmental and historical contexts. *Prerequisite:* Nine hours in geography or biology. Three hours. Gade.

233 Rural Planning. See Agricultural and Resource Economics 233.

242 Problems in Physical Geography. Three hours. Gade, Lind, Meeks, Ryerson.

261 Problems in Vermont Geography. Three hours.

270 Problems in Human Geography. Three hours. Barnum, Bodman, Gade, Meeks, Miles, VanderMeer.

281 Problems in Cartography. Special laboratory projects. *Prerequisite:* 81. Three hours. Barnum, Ryerson.

285 Remote Sensing and Environmental Problems. (Same as Geology 219). Research projects in remote sensing; application of multi-spectral data for environmental studies. *Prerequisite:* 85, Civil Engineering 210, or Forestry 146. Three hours. Lind.

287 Spatial Analysis. (Same as Agricultural and Resource Economics 287) Analysis of spatial pattern and interaction through quantitative models; introduction to measurement, sampling, and covariation in a spatial framework. *Prerequisite:* Graduate standing in geography or planning. Three hours. Bodman.

297, 298 Readings and Research. Credit as arranged.

300 Graduate Tutorial. Readings and

research on topics arranged individually by students with instructors; attendance in appropriate undergraduate courses may be required. *Prerequisite:* Permission of instructor. Three hours.

391 Master's Thesis Research. Credit as arranged.

GEOLOGY

Professors Hunt, and Stanley; Associate Professor Drake (Chairperson); Assistant Professors Bucke, Doolan, Hannah, and Mehrtens; Adjunct Professors Ratte, and Hatch.

Research programs are oriented in the following areas: sedimentary, metamorphic, igneous and structural evolution of the northern Appalachians and western Cordillera; petrogenesis of mafic schists and ultramafic rocks; petrofabric and structural analysis of deformed rocks; selected problems in mineralogy and crystal chemistry; low temperature/pressure geochemistry; geologic history and recent sedimentation in Lake Champlain; evolution, ecology and ontogeny of invertebrate fossils. Interdisciplinary studies are available. Thesis topics should be in accord with faculty interests.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in an appropriate field; 12 semester hours in Geology; satisfactory scores on the general (aptitude) Graduate Record Examination. Year courses in Chemistry, Physics or Biology and Calculus or in an approved ancillary science strongly recommended.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of one year of graduate study plus a comprehensive examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Thesis and advanced courses in Geology must total at least 30 semester hours, including two out of the three courses, 355, 356, 366. Advanced courses in related sciences are encouraged and may be substituted for some selected Geology courses on approval by the departmental advisor. All students must complete successfully a course in field geology before graduation. This can be satisfied by Geology 238, a comparable course at another institution, recognized experience with a state survey, U.S. Geological Survey, and oceanographic institute, a geolimnological group or industry. Satisfactory completion will be determined by the Departmental Studies Committee.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS

1. A bachelor's degree from an accredited institution;
2. Certification as a teacher of a physical or natural science;
3. Satisfactory scores on the Graduate Record Examination (general portion).

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS

Satisfactory completion of one year of graduate study plus departmental recommendation.

MINIMUM REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN TEACHING (GEOLOGY)

Thirty hours of course work that will strengthen the student's background in earth science. Up to 12 hours of 100-level courses may be chosen if applicable. Course work may be chosen from supporting subject areas as well as from geology. Each student, in conference with his adviser, will develop a program suited to his/her needs and background. No thesis is required; however, each degree recipient must complete a general written or oral examination.

A program is also offered leading to the degree of Master of Arts in Teaching, see p. 49.

COURSES OFFERED

211 Seminar in Sedimentary Process. Clastics. Selected readings and field studies emphasizing the interpretation of sedimentary deposits including transportation and geomorphology of ancient and recent sedimentary environments. *Prerequisite:* 155, permission of instructor. Three hours. Mehrtens.

212 Seminar in Sedimentary Process. Carbonates. Paleoenvironmental analysis of carbonate rocks including selected readings, field investigations, and petrographic studies. *Prerequisites:* 155, 121, permission of instructor. Three hours. Mehrtens.

219 Special Topics in Remote Sensing of the Environment. See Geography 285. Three hours.

221 Soil Classification and Land Use. See Plant and Soil Science 261. Three hours. Bartlett.

235 Advanced Structural Geology. Selected topics in analytical structure. *Prerequisite:* 166. Three hours. Stanley.

238 Advanced Field Geology. Field mapping in Vermont. Methods of analysis of field data. Geological reports. Held in late summer. *Prerequisite:* 166 and permission of instructor. Three hours.

240 Plate Tectonics. Development and current status of plate-tectonic concepts with applications to selected parts of the globe. *Prerequisites:* 155, 156 and 166. Three hours.

242a, b Regional Geology. (a) Discussion of the geology of a selected region of North America; (b) A 4-week summer field trip to the area in question. *Prerequisites:* 105, 111; 242a for 242b. Four hours.

245 Geology of the Appalachians. Origin of mountain belts; Appalachian mountain system discussed in terms of sedimentation, stratigraphic, structural, tectonic and petrologic processes active in modern continental margins. *Prerequisites:* 105, 155. Three hours. Doolan.

250 Advanced Mineralogy. Crystallographic, chemical, and physical properties of the common rock-forming minerals. *Prerequisite:* 111. Three hours.

252 Clay Mineralogy. Structure, composition, properties, occurrence, origin, distribution, environmental significance of the various clay minerals. Laboratory techniques in identification of clay minerals, measurement of their physical and chemical parameters. *Prerequisite:* Permission of instructor. Three hours. Bucke.

254 Geochemistry. The application of basic concepts in chemistry to geological problems, including solution geochemistry, weathering, mineral paragenesis, and the effects of pressure and temperature. *Prerequisite:* Chemistry 1, 2; 155 or 156 or permission of instructor. Three hours. Drake.

262, 263 Seminar in Petrology. Modern concepts of the evolution of igneous and metamorphic rocks. Emphasis directed

toward application of petrologic concepts to interpretations of earth history and tectonophysics. *Prerequisite:* 156 or equivalent. Three hours. Hannah, Doolan.

270 Invertebrate Paleontology. Description, classification, indentification, and interpretation of selected invertebrate fossil groups. Individual projects and field trips. *Prerequisite:* 121, or permission. Three hours. Hunt.

272 Recent Sedimentation. Investigation of recent sedimentary environments using geolimnological and oceanographic techniques. Group and individual projects. *Prerequisites:* 155 or equivalent. Three hours. Hunt.

275 Geology of Oil and Gas. Origin, migration and entrapment of petroleum. Geology and classification of source and reservoir rocks and traps. Methods of subsurface analysis of sedimentary rocks and basin analysis. *Prerequisite:* 155 or permission. Three hours. Bucke.

291 Seminar in Geology. Selected topics of current interest. *Prerequisite:* Senior or graduate standing. One to three hours. Staff.

355 Paleogeography. Study of paleopositions of continents and the distribution of land areas and ocean basins through geologic time in the context of plate tectonics. *Prerequisite:* Permission of instructor. Three hours. Mehrtens.

356 Petrography of Igeneous and Metamorphic Rocks. Identification and interpretation of major rock-forming minerals and textures as seen in thin sections of selected igneous and metamorphic rocks. *Prerequisites:* 156, 145a, b or equivalent. Four hours. Doolan, Hannah.

366 Structural Analysis of Deformed Rocks. Mechanisms of rock deformation; fracture phenomena and analysis; fault zone characteristics; fold generation analysis. Stress and strain interpretation of deformational features in rocks and minerals. Field work. *Prerequisites:* 145, 166. Four hours. Stanley.

371 Advanced Readings. Readings and research problems intended to contribute to the program of graduate students in phases of geology for which formal courses are not available. *Prerequisite:* Graduate standing in geology. One to three hours. Staff.

391 Master's Thesis Research. Credit as arranged.

GERMAN

Professor Mieder (Chairperson); Associate Professors Doane, Richel, and Scrase; Assistant Professor Mahoney.

Current research interests include East German literature; history of the German language; medieval literature; literature of the 18th, 19th, and 20th centuries; and folklore.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES 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. Satisfactory scores on the Graduate Record Examinations general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS

Thirty hours of graduate level courses including German 281, 282; additional courses in German, which may include two advanced courses in a related field (six hours), thesis research (six-12 hours).

The department also offers a program leading to the degree of Master of Arts in Teaching: see p. 49. Satisfactory scores on the Graduate Record Examination general (aptitude) section, are prerequisite to acceptance to candidacy for this degree.

COURSES OFFERED

201 Proseminar: Methods of Research and Bibliography. An introduction to tools and methods of research. *Prerequisites:* 101, 102 or the equivalent. Three hours. Mieder. Alternate years.

203 Development of German Intellectual Movements. A comprehensive survey of the history of ideas as a framework for the study of German literature. *Prerequisites:* 101, 102 or the equivalent. Three hours. Mahoney. Alternate years.

204 Courtly Epic and Minnesang. Cultural background and major works of medieval classicism. *Prerequisite:* 101, 102 or the equivalent. Three hours. Mieder. Alternate years.

205, 206 Goethe and Schiller and Their Time. Origin, development, characteristics and criticism of German Classicism. *Prerequisites:* 101, 102 or the equivalent. Three hours. Mahoney, Richel, Scrase. Alternate years.

207 Nineteenth Century Prose. Masterpieces of narrative prose by representative authors such as Kleist, Droste-Hülshoff, Stifter, Storm and Keller. *Prerequisite:* 101, 102 or the equivalent. Three hours. Mieder. Alternate years.

208 Nineteenth Century Drama. Works by Kleist, Büchner, Grillparzer, Hebbel, Wagner and the early Hauptmann. *Prerequisites:* 101, 102 or the equivalent. Three hours. Richel. Alternate years.

209, 210 The Twentieth Century. Selected works in poetry, prose and drama by Brecht, George, Hauptmann, Hofmannsthal, Kafka, Thomas Mann, Rilke, and others. *Prerequisites:* 101, 102 or the equivalent. Three hours. Doane, Scrase. Alternate years.

221, 222 Advanced Composition and Conversation. Guided conversation, discussion and advanced oral and written drill in German. Modes of expression and stylistic devices of modern German based on analysis of selected texts. *Prerequisites:* 121, 122 or equivalent. Three hours. Doane, Mieder.

232 History of the German Language. Introduction to Germanic linguistics, the comparative method, and linguistic reconstruction. Linquistic development of German from Indo-European to present. No knowledge of older stages of the language necessary. *Prerequisites:* 121, 122 or the equivalent. Three hours. Mieder. Alternate years.

282, 282 Seminar. Special readings and research. Three hours. Staff.

391 Master's Thesis Research. Credit as arranged.

HISTORIC PRESERVATION

Chester H. Liebs, (Director); Professors Conrad, Felt, Hand, Haviland, Janson, Lipke, Sargent, Stout; Assistant Professors McGovern, Power; Philip Marshall (Architectural Conservator), Peter Thomas (UVM Contract Archeologist); Distinguished Visiting Faculty Eric N. DeLony, Maximilian L. Ferro, Kathlyn Hatch, Edmund Kellogg, Roger Lang, Nancy Boone.

An interdisciplinary graduate program leading to a Master of Science in Historic Preservation is offered by the History Department in partnership with the Department of Art, and with the cooperation of the Departments of Anthropology and Agricultural and Resource Economics, and the Environmental Studies Program. Enrollment is limited to a small number of qualified participants who are seeking an intensive, community-oriented educational experience which effects a balance between academic and professional training. As its underlying philosophy, the program recognizes the diverse contributions, both high-style and vernacular, that every generation has made to the built environment and views historic preservation as a form of management which keeps these contributions in balance. The program is designed to develop future leaders to help foster economic growth through the stewardship of historic resources and

to provide a focus within northern New England for research on and public awareness of the region's outstanding built environment. The program publishes an occasional news journal, *Possibilities,* on the built environment of Vermont, and cosponsors numerous special training workshops and a Historic Preservation Summer Institute. The program also has a newly-organized Architectural Conservation and Education service which provides technical preservation and educational services on a contract basis. The program has been certified as meeting standards for professional training established by the National Council for Preservation Education.

Applicants desiring financial aid may be nominated for Graduate College Fellowships or for Graduate Teaching Fellowships in the History Department. The demands of the Historic Preservation program, however, preclude its students from holding Student Personnel Fellowships.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE IN HISTORIC PRESERVATION

(1) A baccalaureate degree with a major in a preservation-related field such as architecture, architectural history, history, planning, business administration, economics, engineering, interior design, law, or environmental studies. (2) Applicants must take the general (aptitude) portion of the Graduate Record Examination and the subject (advanced) test, if one exists, in their field of specialization, and submit a sample independent research paper, design project, or other evidence of preservation-related professional ability.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Admission to this highly competitive program constitutes acceptance to candidacy as well.

MINIMUM DEGREE REQUIREMENTS FOR THE MASTER OF SCIENCE

(1) Thirty-six credit hours of course work. A minimum of 18 credit hours (including an internship or thesis) must be taken in historic preservation. Participants are urged to choose electives that will fill in gaps in their previous training. (2) A comprehensive examination given during the third semester. (3) An internship in a preservation agency, or a written thesis. This may be undertaken upon completion of two or three semesters of concentrated course work. At the conclusion of the internship, an oral presentation describing work accomplished will be given before a jury of practicing professionals for evaluation. (4) Historic Preservation 201, 301, 302 and 303 or 304 are required courses for the degree. Students will also normally take History 351 (Proseminar in American Cultural History) and Art 207 (History of American Architecture) unless they have had sufficient backgrounds in these areas.

COURSES OFFERED

201 Architecture and the Environment (Same as Art 223). An introduction to the basic concepts and skills necessary to identify, document, and manage the nation's historic resources. Three hours. Liebs.

202 Special Topics. Courses are offered yearly by visiting faculty under this number, in specialized areas of historic preservation, through the Division for Continuing Education. Current offerings include:

Conservation Techniques for Historic Structures. Structural systems, materials found in historic resources; methods for conservation. Preservation of brick, stone, wood, plaster, metals, paints, etc. Introducing new systems into structures without violating historical integrity. Three hours. Ferro.

Historic Preservation: Development Economics. Survey of economic, financial aspects of real estate development pertaining to preservation and adaptive use (market studies, proformas). Field trips. Actual proposal development for underutilized historic properties. Three hours. Lang.

Historic Preservation Law. Legal issues in conservation of the built environment. Basic legal techniques for protection of historic structures (historic districts, protective legislation, easements, covenants). Study of significant court decisions. Three hours. Kellogg.

Historic Preservation: Commercial Archeology. Mid-20th-century built environment. Origin and evolution of structures, signs, symbols of the recent past. Techniques for documentation, selective conservation. Field trips, class project. Three hours. Liebs.

301 Historic Preservation Contemporary Practice. Detailed study of current historic preservation practice through field trips, seminars with practicing professionals; technical training in architectural taxonomy, environmental impact review, funding solicitation, preservation agency administration. Six hours. Liebs, Hatch, and distinguished visiting lecturers.

302 Preservation Advocacy Project. Third-semester graduate students apply developed professional skills to actual community preservation problems. Projects include strategy development, securing and allocating funds, research, advocacy, and implementation. Three hours. Liebs.

303 Internship. Participants will devote a semester to preservation within an appropriate institution or agency. Three hours. Liebs and Stout.

304 Master's Thesis Research. Credit as arranged.

305 Special Topics. Credit as arranged.

306 Special Readings and Research. Credit as arranged.

HISTORY

Professors Andrea, Daniels, Davison, Evans (Emeritus), Felt, Hand, Hutton (Director of Graduate Studies), Metcalfe (Chairperson), Schmokel, Schultz (Emeritus), Seybolt, Spinner, Steffens, and Stout; Associate Professors Liebs, (Director, Historic Preservation Program), Overfield, Stoler, and True; Assistant Professors Kenny, McGovern and Rodgers; Adjunct Professor Morrissey.

Research interests include American history of the colonial, early federal, Civil War, and twentieth-century periods; American social and legal history; Women in America; American foreign relations; American military history; Medieval Europe; the Renaissance and the Reformation; French history; English history (Tudor-Stuart and recent); twentieth-century German, Russian and Chinese history; the Communist movement and Soviet foreign policy; East European nationalism; Canadian history (including French Canada); Latin American history; African history; music history; history of science; and historic preservation. Two scholarly journals (*The American Review of Canadian Studies,* and *Chinese Education*) are edited by members of the History Department. For ancient history, see Greek and Latin.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS AND MASTER OF ARTS IN TEACHING

Applicants should have an undergraduate major in history, or in a related field of the social sciences or humanities with the equivalent of a minor in history. They must take the Graduate Record Examination, both general (aptitude) and subject (advanced) history, and submit with the application a sample of writing, such as a research paper done in the course of undergraduate study.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

Each student's Studies Committee will certify admission to candidacy when it has approved a course of study (which may include remedial work such as courses in appropriate foreign languages) and a tentative thesis topic.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS IN TEACHING

See page 49.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS

Twenty-four hours in History, including six hours in thesis research, and six additional hours in History or a related field. The Comprehensive Examination must normally be taken before beginning the third semester; it will include questions in at least two different historical areas. Completion and successful oral defense of a thesis.

COURSES OFFERED

210, 211 Seminar in History of Traditional Societies. Three hours.

220, 221 Seminar in Historical Methods, Historiography, History of Ideas. Three hours.

222 Seminar in Comparative History. Three hours.

230, 231 Seminar in Third World History. Three hours.

250, 251 Seminar in Modern Europe. Three hours.

261 Seminar in Vermont History. A topical approach to the Vermont experience through original research utilizing primary sources available at the University of Vermont, the Vermont Historical Society and the Vermont State Library. *Prerequisites:* History 71 or permission of instructor. Three hours. Hand, True.

278 Seminar in Foreign Policy of the USSR (Same as Political Science 278). An historical topical study of Soviet foreign relations since 1917, including the international Communist movement and ideological, economic, and strategic aspects. Three hours. Daniels.

280, 281 Seminar in Early American History. Three hours. Stout.

282, 283 Seminar in Modern American History. Three hours.

284 Seminar in Canadian History. Three hours. Metcalfe and Kenny.

285 Seminar in French Canada. Three hours. Kenny.

300 Graduate Tutorial. Readings and research in a specific area; topics to be individually arranged; attendance in appropriate undergraduate courses may be re-

quired (see undergraduate catalog). *Prerequisite:* Permission of instructor. Variable credit. Staff.

301 Introduction to Graduate Study in History. Historical method, philosophy of history, the history of history writing. Three hours. Staff.

351 Pro-Seminar in American Cultural History. Intended primarily for students in Historic Preservation, but open to other graduate students. Three hours. Stout, Felt.

379 Interpretations of American History. An intensive reading course covering the major periods and events in America from the Revolution to the Cold War. Three hours. Hand and Staff.

380 Interpretations of European History. An intensive reading course covering the major periods and events in Europe from the Renaissance to the Cold War. Three hours. Overfield and Staff.

391 Master's Thesis Research. Required of all candidates for the M.A. Normally arranged for two semesters at three hours each.

397 Special Readings and Research. Directed individual study of areas not appropriately covered by existing courses. Variable credit.

HUMAN NUTRITION AND FOODS

Professor Carew; Associate Professors Livak, Schlenker (Chairperson), Tyzbir; Assistant Professors Bartel, Pintauro, Ross, Soule; Extension Professor Coffey; Extension Assistant Professor Wright; Research Assistant Professor Clarke; Adjunct Professor Stowell.

Department research encompasses both basic and applied aspects of human nutrition. Research is being conducted on: metabolism of brown adipose tissue and dietary influences upon mitochondrial energy metabolism; food nutrient analysis; the relationship between dietary fiber, intestinal microflora and colon cancer; food habits and nutrient requirements of the aged; testing methods of nutrition education for various age groups and educational levels; lipid metabolism in patients with renal disease and use of animal models for clinical studies; toxicants in foods and methods employed for evaluation of the safety of foods.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in nutrition or a science-related field. Satisfactory scores on the Graduate Record Examination, general (aptitude) portion.

MINIMUM DEGREE REQUIREMENTS

Thirty hours including thesis research (six to 15 hours). Twenty-one hours should be earned in the field of specialization; nine hours may be selected from related areas; courses in statistics and research methods are required.

COURSES OFFERED

235 Recent Advances in Foods and Nutrition. Interpretation, application of particular topics, trends in foods and nutrition as evidenced through literature and research. May be taken more than once for a maximum of nine hours. *Prerequisites:* chemistry, physiology, 43 and permission of instructor. Three hours.

236 Introduction to Food and Nutrition Research. Introduction to laboratory techniques in food and nutritional sciences. *Prerequisites:* 135 and a course in biochemistry with laboratory. Three hours. Pintauro.

237 Readings in Food Science. Critical survey of the literature on the recent devel-

opments in food research. *Prerequisite:* 135 and biochemistry. Three hours. Pintauro.

240 Methods in Nutrition Education. Observation, needs assessment, planning and presenting of appropriate methods and materials for an identified audience in a community, school or institutional setting. *Prerequisites:* a college course in nutrition; 130; permission based upon an interview. Three hours. Soule.

241 Nutrition and Aging. Study of the physiologic, psychologic, sociologic and economic factors which influence the nutrient requirements, nutritional status and food habits of older people. *Prerequisite:* 144. Three hours. Schlenker.

242 Advanced Nutrition. A study of nutrients and their specific functions in metabolic processes integrating cellular physiology, biochemistry and nutrition. Prerequisites: 3 hours in nutrition and a course in biochemistry and physiology. Three hours. Tyzbir.

245 Nutritional Biochemistry I. Comprehensive study of metabolism of carbohydrates, lipids and protein with emphasis on hormonal control, nutritional and metabolic interrelationships and dietary abnormalities (e.g. starvation and obesity). *Prerequisites:* 242 and permission of instructor. Three hours. Tyzbir.

247 Diet Therapy. Adaptations of the normal diet in conditions of health and disease including the physiological and psycho-sociological implications. *Prerequisites:* 130, 144 and 242. Four hours. Ross.

249 Nutrition Seminar. A review of recent developments in nutrition research. *Prerequisite:* 242 and permission of instructor. One hour.

290 Introduction to Research. Research procedures with lectures and discussions of problem selection, objectives, bibliographical techniques, and analysis of data. *Prerequisite:* Departmental permission. Two hours.

291 Special Problems. Reading, discussion, and special field and/or laboratory investigations. *Prerequisite:* Departmental permission. Students may enroll more than once for a maximum of twelve hours. One to six hours.

294 History of Nutrition. Foremost investigators and methods involved in the development of present day nutritional knowledge. *Prerequisite:* Three hours in nutrition. One hour.

295 Special Topics. Lectures, laboratories, readings or projects relating to contemporary areas of study. Enrollment may be more than once, maximum of 12 hours in 195 and 295 combined. Graduate students are limited to 6 hours in 295. *Prerequisite:* Departmental permission.

296 Field Experience. Professionally oriented field experience under joint supervision by faculty and business or community representative. Hours arranged; maximum up to 15 hours in 196 and 296 combined. *Prerequisite:* Departmental permission.

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. *Prerequisite:* One of the following: 242 or a 200 level course in biochemistry. Three hours. Alternate years, 1983-84.

391 Master's Thesis Research. Credit as arranged.

MATERIALS SCIENCE (Multidisciplinary)

Steering Committee Members: Director R. Anderson (Electrical Engineering); T. Flanagan (Chemistry); L. Scarfone (Physics); B. vonTurkovich (Mechanical Engineering).

Participating faculty are from the following departments: Computer Science and Electrical Engineering, Civil and Mechanical Engineering, Physics, and Chemistry.

The program in Materials Science is multidisciplinary. It is involved with the mechanical, electrical, chemical and physical properties of materials — primarily solids — and applications of these materials. It is multidisciplinary in the sense

that it combines the theoretical and experimental capabilities of a variety of disciplines and applies them to the solution of complex scientific and engineering problems. Problems such as corrosion, analysis and synthesis of electronic materials, development of bulk and thin film electronic devices and integrated circuits, optimization of mechanical properties of structural materials, and failure analysis are typical examples requiring such an interdisciplinary approach. The course program gives a broad background in materials. It also provides flexibility allowing specialization in particular areas of interest.

The program in Materials Science offers the Master of Science Degree and the Doctor of Philosophy Degree. Each student must meet the general requirements for admission as outlined under the Regulations of the Graduate College in the Graduate College Catalogue. Students in the program are sponsored by the participating department which best reflects the students' backgrounds and interests.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

A bachelor's degree in Physics, Chemistry, Metallurgy, Engineering, or Mathematics. Applicants with other backgrounds will be evaluated individually.

MINIMUM DEGREE REQUIREMENTS

The above requirements for admission must be supplemented in either of the following ways:

Plan A: With Thesis: 30 graduate credit hours of an approved program of study including at least 18 credit hours of course work; completion of at least one three-credit hour course in each of the following categories: solid state theory, quantum mechanics, applied mathematics, and materials properties of solids; satisfactory completion of a comprehensive examination, and satisfactory completion of an M.S. thesis including its defense at an oral examination.

Plan B: Without Thesis: 30 credit hours of an approved program of study; completion of at least one three-credit hour course in each of the following categories: solid state theory, quantum mechanics, applied mathematics, and materials properties of solids, and satisfactory completion of a comprehensive examination.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

An accredited master's degree (or equivalent) in Physics, Chemistry, Metallurgy, Engineering, Mathematics, or Materials Science.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Successful completion of a Ph.D. comprehensive examination in Materials

Science and demonstrated competence in computer programming. The comprehensive examination includes the areas of quantum mechanics, solid state theory, applied mathematics, thermodynamics, and materials properties of solids.

MINIMUM DEGREE REQUIREMENTS

In addition to the above, the following are required:

A minimum of 75 graduate credit hours including a minimum of 20 in dissertation research. An overall grade point average in graduate courses of 3.25 or better. Completion of at least one three-credit hour course in each of the following categories: solid state theory, quantum mechanics, applied mathematics, thermodynamics and kinetics, and one course in each of two categories dealing with materials properties of solids. Satisfactory completion of a Ph.D. dissertation including its defense at an oral examination.

COURSES OFFERED

The program of Materials Science offers no courses of its own. All courses in a student's program are offered by the individual departments — primarily Electrical Engineering, Mechanical Engineering, Mathematics, Statistics, Physics, and Chemistry.

MATHEMATICS

Professors Chamberlain, Cooke, Moser (Chairman), Riggs, Sylwester and Wright; Associate Professors Ashikaga, Burgmeier, Foote, and Haugh; Assistant Professors Archdeacon, Costanza, Dinitz, Kadas, Margolis, Pence, and Zwick; Lecturers Aleong, Johansson, Kost, Lawlor, Morency, and Puterbaugh.

The Department of Mathematics offers master's degree programs which are sufficiently flexible to accommodate diverse career interests of its graduate students and prepare them for further graduate study. A majority of the advanced courses and current research interests of the faculty are in applied mathematics, including differential equations, probability and statistics, numerical analysis, and discrete mathematics.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES AND ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Thirty semester hours beyond intermediate calculus, including a year of advanced calculus. Satisfactory scores on the general (aptitude) and subject (advanced) sections of the Graduate Record Examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Plan A: 24 semester hours of acceptable graduate credits in advanced Mathematics courses; six semester hours in thesis research.

Plan B: 30 semester hours of acceptable graduate credits in advanced Mathematics courses; no thesis required.

Under both Plan A and Plan B students must already have, or must acquire a knowledge of the content of the following courses: Mathematics 251, 331, 333, and 252 or 274. Also, students must satisfactorily complete at least four 300-level Mathematics courses and the seminar 382. For a concentration in applied mathematics the department recommends Mathematics 238, 330 and 332.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES AND ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS

A bachelor's degree from an accredited institution and certification as a teacher of mathematics. Three years of experience teaching secondary school mathematics. Satisfactory scores on the Graduate Record Examination (aptitude portions.)

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS

Thirty hours of course work in Mathematics, Statistics, and Computer Science which will broaden and balance the undergraduate work in the mathematical sciences. Each student, in conference with his/her faculty advisor, will develop a program suited to his/her needs and background. Up to 12 hours of 100-level courses may be chosen if applicable. No thesis is required; each degree recipient must pass a written or oral comprehensive examination.

REQUIREMENTS FOR THE DEGREE MASTER OF ARTS IN TEACHING

The department offers a program leading to the degree of Master of Arts in Teaching: (see page 49).

COURSES OFFERED

207 a,b Probability Theory. See Statistics 251 a,b.

217 Introduction to the Theory of Computing. See Computer Science 242.

218 Automata Theory. Capabilities and limitations of finite state automata. Minimization, control and identification of machines. State identification and fault detection experiments. Finite state recognizers and regular expressions. *Prerequisite:* 104. Three hours.

221 Deterministic Models in Operations Research. Techniques of linear and dynamic programming and game theory. Graphs and tree models. Classical problems are discussed, and problem formulation stressed. *Prerequisites:* 124; 121 desirable. Three hours. Alternate years, 1982-83.

222 Stochastic Models in Operations Research. Stochastic processes and their use in analysis of industrial problems. Markov chains, queueing theory, linear and dynamic programming under uncertainty. *Prerequisites:* Stat 151 or 251 or Math 207, 221. Three hours. Alternate years, 1982-83.

223 Introduction to Formal Language Theory. Introduction to theory and applications of context-free languages. Phrase structure and context-free grammars, normal forms, pushdown automata, decision problems, power series in non-commuting variable, applications to parsing. *Prerequisites:*104, 217 and/or 218 highly recommended. Three hours. Alternate years, 1982-83.

224 Analysis of Algorithms. Models of

computation, design of efficient algorithms. Integer and polynomial arithmetic. Sorting, binary search trees and adaptive merging. NP-complete problems. Parallel processing. *Prerequisites:*104, 121 and CS 103. Three hours. Alternate years, 1982-83.

230 Ordinary Differential Equations. Solutions of linear ordinary differential equations, the Laplace transformation, and series solutions of differential equations. *Prerequisites:* 121, 124. Three hours.

236 Calculus of Variations. Necessary conditions of Euler, Legendre, Weierstrass and Jacoby for minimizing integrals. Sufficiency proofs. Variation and eigenvalue problems. Hamilton-Jacoby equations. *Prerequisite:* 230. Three hours. Alternate years, 1983-84.

237 Numerical Analysis I. Concept of error, polynomial approximation, summation techniques, solution of equations, linear systems, eigenvalues. *Prerequisites:* 121, 124 and knowledge of computer programming. Three hours.

238 Numerical Analysis II. Finite differences, differentiation and integration, ordinary and partial differential equations, linear programming. *Prerequisite:* 237. Three hours.

240 Operational Mathematics. Orthogonal functions, transforms and boundary value problems. *Prerequisite:* 230 or 271. Three hours.

241 Advanced Calculus I. Calculus of several variables, Euclidean spaces, open and closed sets, limits, continuity, differentiation (emphasizing linearity), maxima and minima, Lagrange multipliers, integration of functions of several variables. *Prerequisites:* 121 and 124. Three hours.

242 Advanced Calculus II. Jacobians, change of variables in a multiple integral, line and surface integrals, Green's, Gauss' and Stokes' Theorems, Fourier Series, Fourier and Laplace transforms. *Prerequisite:* 241. Three hours.

251 Modern Algebra. Fundamental concepts of Abstract Algebra. Sets, mappings, groups, rings, integral domains, fields, homomorphisms and isomorphisms. *Prerequisites:* 22 and 104; highly desirable. Three hours.

252 Advanced Linear Algebra. Linear transformations and vector spaces, including Jordan forms. Symmetric, Hermitian, orthogonal and unitary matrices, and quadratic forms. *Prerequisites:* 124; 251 desirable. Three hours. Alternate years, 1983-84.

253, 254 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:* 104; 253 for 254. Three hours. Alternate years, 1982-83.

255 Elementary Number Theory. Divisibility, prime numbers, Diophantine equations, congruence of numbers, and methods of solving congruences. *Prerequisite:* One year of calculus. Three hours.

257 Theory of Groups. The study of the various kinds and structures of groups. *Prerequisite:* 251. Three hours. Alternate years, 1983-84.

258 Galois Theory. The study of Galois theory leading to the insolvability of general quintic equations by radicals and theorems on constructions with straightedge and compass. *Prerequisite:* 257. Three hours. Alternate years, 1983-84.

260 Foundations of Geometry. Geometry as an axiomatic science; various non-Euclidean geometries; relationships existing between Euclidean plane geometry and other geometries; invariant properties. *Prerequisite:* One year of calculus. Three hours.

261 The Development of Mathematics. Historical development of the mathematical sciences with emphasis on interrelations among them. Individual assignments correspond to background and interests of students. *Prerequisite:* Nine hours of college mathematics. Three hours.

264 Vector Analysis. Introduction to general vector methods including the elements of vector algebra and vector calculus with applications to physics and mechanics. *Prerequisite:* 121. Three hours. Alternate years, 1983-84.

271 Applied Mathematics for Engineers and Scientists I. Matrix theory, vector analysis, linear ordinary differential equations. Emphasis — methods of solution (including numerical). No credit for mathematics majors. For mathematics concentration, advise sequence beginning with 230. *Prerequisite:* 121. Three hours.

272 Applied Analysis. Partial differential equations of mathematical physics, calculus of variations, functions of a complex variable, Cauchy's theorem, integral formula, conformal mapping. *Prerequisite:* 230 or 271. Three hours.

273 Introduction to Combinatorics. Combinatorial relations, elementary problems of existence, enumerative combinatorics; generating functions and graphs. Applications to problems in probability, mathematics of computers, graph theory and number theory. *Prerequisite:* 104. Three hours. Alternate years 1982-83.

274 Computational Linear Algebra. Efficient computer algorithms for Gaussian elimination, stable orthogonal and least-squares matrix computations, matrix eigenvalue computations. Analysis of numerical stability of algorithms, determination of conditioning of matrices. *Prerequisites:* 124 or 271, modest experience with digital computer programming. Three hours. Alternate years, 1982-83.

276 Mathematics of Space Flight. Topics include orbit determination and prediction of natural and artificial satellites and projectiles. Astrodynamic coordinate systems and their transformations. Integration schemes and perturbation theory. Attitude determination. *Prerequisites:* 237 and modest experience with digital computer programming. Three hours. Alternate years, 1982-83. Riggs.

295 Special Topics. Lectures, reports and directed readings on advanced topics as announced. *Prerequisite:* permission of instructor. Credit as arranged. Offered as occasion warrants.

325 Advanced Automata Theory. Algebraic structure theory of automata, monoids, semigroups, semiautomata; homomorphisms, simulation, realization. Decomposition theory, including permutation and reset machines. Topics of current interest in complexity of automata. *Prerequisite:* 218. Three hours. Alternate years, 1982-83.

330 Advanced Ordinary Differential Equations. Linear and non-linear systems, approximate solutions, existence, uniqueness, dependence on initial conditions, stability, asymptotic behavior, singularities, self-adjoint problems. *Prerequisite:* 230. Three hours. Alternate years, 1982-83.

331 Theory of Functions of Complex Variables. Differentiation, integration, Cauchy-Riemann equations, infinite series, properties of analytic continuation, Laurent series, calculus of residues, contour integration, meromorphic functions, conformal mappings, Riemann surfaces. *Prerequisite:* 242. Four hours. Alternate years, 1982-83.

332 Approximation Theory. Interpolation and approximation by interpolation, uniform approximation in normed linear space, spline function, orthogonal polynomials. Least square, Chebychev approximations, rational functions. *Prerequisites:* 124, 238. Three hours. Alternate years, 1982-83.

333 Theory of Functions of Real Variables. The theory of Lebesgue integration, Lebesgue measure, sequences of functions, absolute continuity, properties of L^P spaces. *Prerequisite:* 242. Four hours. Alternate years, 1983-84.

335, 336 Advanced Real Analysis. L^2 spaces, L^P spaces; Hilbert, Banach spaces; linear functionals, linear operators; completely continuous operators (including symmetric); Fredholm alternative; Hilbert-Schmidt theory; unitary operators; Bochner's Theorem; Fourier-Plancherel, Watson transforms. *Prerequisites:* 333; 335 for 336. Three hours. Alternate years, 1982-83.

339 Partial Differential Equations. Classification of equations, linear equations, first order equations, second order elliptic, parabolic and hyperbolic equations, uniqueness and existence of solutions. *Prerequisites:* 230, 242. Three hours. Alternate years, 1983-84.

382 Seminar. Topical discussions with assigned reading. Required of MS degree candidates. One hour.

391 Master's Thesis Research. Credit as arranged.

MECHANICAL ENGINEERING

Professors Emeriti Duchacek, Martinek, and Tuthill; Professors Francis, Hermance (Chairperson), Hundal, Marshall, Outwater, Pope, and von Turkovich; Associate Professor Carpenter; Adjunct Professors Liu and McLay; Lecturer Durham.

Master of Science and Doctor of Philosophy programs are offered. Candidates holding degrees other than those in Mechanical Engineering are encouraged to apply. In such cases, it may be necessary for the student to complete the entrance qualifications without receiving credit toward his/her graduate studies. The general requirements for admission, as outlined under the Regulations of the Graduate College, must be met. Areas of research interest include brittle materials; fracture mechanics of composite materials; shell structural analysis; non-linear vibrations; biomechanics; stability of fluid jets; radiative heat transfer; matrix methods in structural mechanics; continuum mechanics; physical and mechanical metallurgy; solidification; mechanical and thermal processing of metals.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An accredited bachelor's degree in Mechanical Engineering or its equivalent.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

One semester of satisfactory performance in graduate courses.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Approved courses in engineering, mathematics and sciences with thesis research; 30 credit hours.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

An accredited master's degree in Mechanical Engineering or its equivalent.

REQUIREMENT FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Successful completion of the Ph.D. comprehensive written examinations.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The degree of Doctor of Philosophy requires of candidates a minimum of 75 credit hours to be earned in course and in dissertation research. At least 40 credit hours must be earned in courses and seminars and a minimum of 25 credit hours must be earned in dissertation research. Each candidate must be able to comprehend the literature of his/her field in at least one foreign language provided it is required for his/her dissertation work. The requirements specified under Regulations of the Graduate College must also be met.

COURSES OFFERED

206 Application of Computers in Engineering. Utilization of computer as an engineering tool for the solution of complex engineering problems. Three hours. Hundal.

208 Biomechanics. Application of principles of mechanics to biological systems, emphasis on human body. Mechanics of soft tissues, bones, muscles, biofluids. Kinematics and whole body dynamics. Biomaterials. Prosthetic devices. *Prerequisite:* Permission of instructor. Three hours. Pope.

211 Advanced Mechanical Structures I. Energy methods; topics in solid mechanics, introduction to elasticity. Three hours.

222 Advanced Mechanical Structures II. Elasticity; matrix methods. Three hours.

231 Materials Processing II. Fundamental theory of selected mechanical and thermal processing techniques with applications. *Prerequisites:* 233 or equivalent. Three hours. von Turkovich.

243 Compressible Flow. Foundations of compressible flow; isentropic flow; normal shock waves; flow in ducts with friction and with heating or cooling; generalized solution of combined effects. *Prerequisites:* 143 and Mathematics 271. Three hours. Martinek.

246 Aerodynamics. Application of the principles of fluid mechanics to the design and performance of aircraft; transition and separation on various shapes; compressibility phenomena. *Prerequisite:* 143. Three hours. Martinek.

252 Engineering Design II. Application of principles of engineering mechanics, material science, thermal science to design of mechanical systems and their components; optimization, fracture mechanics, product design. Group projects from industry. *Prerequisite:* 135. Three hours. Carpenter.

272 Mechanical Behavior of Materials. Elastic and plastic behavior of single crystals, polycrystals; dislocations; approximate plastic analysis; anisotropic materials; hardness; residual stress; brittle, transitional, ductile fractures; fatigue; damping; creep, surface phenomena. Three hours. Outwater.

281, 282 Seminar. Presentation and discussion of advanced mechanical engineering problems and current developments. *Prerequisite:* Graduate engineering enrollment. One hour.

297 Nuclear Engineering. Fission, fusion chain reactions; criticality; neutron diffusion; fast, breeder reactors; design considerations, accident delineation; high pressure, boiling heat transfer; liquid metals; fuel-coolant interaction; transient phenomena; safety. *Prerequisite:* Senior or graduate standing. Three hours. Martinek.

301 Advanced Engineering Design Analysis and Synthesis. Application of fundamental concepts, principles of advanced mathematics, physics, mechanics, electricity, thermodynamics, fluid dynamics, heat transfer, and decision-making processes to design, analysis, synthesis of complex engineering systems. Four hours. Hundal.

302 Engineering Elasticity. Tensors, complex variables, variational methods. Four hours. von Turkovich.

307 Advanced Fluid Dynamics. Stress in continuum; kinematics, dynamics; potential fields; Wing theory; Navier-Stokes equation; hydrodynamic stability; turbulence; laminar, turbulent boundary layer theory; transient flows; free laminar, turbulent flows; mixing. Four hours. Martinek.

308 Advanced Dynamics. Application of Lagrange's equation, Hamilton's principle to mechanical systems. Systems with constraints. Matrix formulation of problems in kinematics, dynamics. Stability of linear, non-linear systems. Three hours. Hundal.

309 Advanced Engineering Thermodynamics. Microscopic thermodynamics; Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics; kinetic theory of gases; transport properties, compressed gases, liquids, solid states; chemical systems; irreversible processes; fluctuations. Three hours. Martinek.

310 Advanced Heat Transfer. Generalized equation of heat conduction; classical integral transforms, approximate solutions; thermal boundary layers; forced and free convection; condensation, boiling, ablative cooling; radiation, statistical theory; mass transfer. Three hours. Martinek.

311 Advanced Gas Dynamics. Compressible flow in ducts; friction, heat transfer; shock waves; small perturbation theory; high speed flows; transonic, supersonic, hypersonic flows; methods of characteristics. Aerodynamic heating; rarified gas flows. Three hours. Martinek.

320 Special Problems in Elasticity. Advanced topics in the theory of elasticity in which there is a particular student and staff interest. Three hours.

322 Special Problems in Dynamics. Advanced topics in dynamics in which there is a particular student and staff interest. Three hours. Hundal.

323 Special Problems in Thermodynamics. Advanced topics in thermodynamics in which there is a particular student and staff interest. Three hours. von Turkovich.

324 Special Problems in Heat Transfer. Advanced topics in heat transfer in which there is a particular student and staff interest. Three hours. Martinek.

325 Special Problems in Materials. Advanced topics in behavior of materials in which there is a particular student and staff interest Three hours. Outwater, von Turkovich.

330 Matrix Methods in Structural Dynamics. Matrices, eigenvalue problems, forced vibration, wave propagation. Three hours. Hundal.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

The following courses are offered infrequently but may be taught where sufficient student interest is demonstrated.

202 Dynamics II. Three hours.

232 Micromanufacturing Technologies. Three hours.

251 Technology and Society Seminar. Three hours.

262 Thermal Systems. Three hours.

303 Stress Analysis (Theory and Experiment). Three hours.

306 Continum Mechanics. Three hours.

321 Special Problems in Fluid Mechanics. Three hours.

MEDICAL MICROBIOLOGY

Professors Albertini, T. Moehring, Schaeffer (Chairperson), and Stinebring; Associate Professors Boraker, Fives-Taylor, Gump, and Novotny; Research Professor J. Moehring; Adjunct Associate Professor Smith.

Research activites include: host-parasite interactions with emphasis on cellular and molecular aspects of mechanisms of pathogenesis; biochemical basis of the action of bacterial toxins; entry and replication of animal viruses; chlamydiae and mycoplasmas; non-antibody resistance mechanisms especially concerning production, storage, and mode of action of interferon; development of nonisotopic immunoassays for detection of immune complexes and cell surface macromolecules; studies of *in vitro* carcinogenesis; studies of cellular aging; biochemical genetics of cultured mammalian cells; isolation and expression of adhesion genes of streptococci in *E. coli;* mechanisms involved in assembly of bacterial structures; transformation of fungi, and the isolation of fungal genes controlling incompatibility and development; genetic toxicology: human biomonitoring; mammalian somatic cell genetics.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

One year of biological science; mathematics through elementary calculus; one year course in Physics (Physics 15 and 16 equivalent); chemistry including one

year of inorganic chemistry, quantitative analysis and one year of organic chemistry (equivalent of Chemistry 1, 2, 123, 131, 132). A student may be admitted pending satisfactory completion of one or two of the above courses during the first semester(s) of graduate study. Satisfactory scores on the general (aptitude) test and subject (advanced) test in Biology of the Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Completion of undergraduate course prerequisites; satisfactory performance on teaching assignments and the cumulative examination.

MINIMUM DEGREE REQUIREMENTS

Participation throughout residence in Medical Microbiology Seminars; Medical Microbiology 305 and Thesis Research 391; approved selected courses offered in the Department of Medical Microbiology; Biochemistry 301-302, 303; teaching assignments as arranged by the Department; successful completion of thesis. Twenty-four hours of course credits, 16 of which must be taken from courses offered by the Department of Medical Microbiology, and six hours of research credits are required.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

One year of biology; chemistry through physical chemistry (equivalent to Chemistry 1, 2, 123, 131, 132, 160 or 161, 162) mathematics through calculus; one year course in physics (Physics 15 and 16 equivalent); additional courses required by the Department depending on the aims of the student. A student may be admitted pending satisfactory completion of one or two of the above courses during the first semester(s) of graduate study. Satisfactory scores on the general (aptitude) test and subject (advanced) test in Biology of the Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Completion of undergraduate course prerequisites; satisfactory performance on teaching assignments and the cumulative examination.

MINIMUM DEGREE REQUIREMENTS

Participation throughout residence in Medical Microbiology Seminars; Medical Microbiology 305 and Thesis Research 491; Biochemistry 301-302, 303; approved selected courses from programs in Medical Microbiology, Biochemistry, and other departments at the discretion of the Department and Studies Committee; teaching assignments as arranged by the Department; successful completion of dissertation. Students are expected to develop proficiency in the use of computer

language and programming. Forty hours of course credits, 20 of which must be taken from courses offered by the Department of Medical Microbiology, and 35 hours of research credits are required.

COMBINED MEDICAL COLLEGE AND GRADUATE COLLEGE DEGREE PROGRAMS

Qualified students, following acceptance into the medical college, may simultaneously enroll in the Graduate College for a Master of Science or Ph.D. degree program in Medical Microbiology. The program would be developed with concurrence of the dean for student affairs in the College of Medicine.

COURSES OFFERED

203 The Mammalian Cell in Biomedical Research. Cell and molecular biology of cultured vertebrate cells; principles and techniques of cell culture. Applications to biomedical research: regulation, differentiation, cytogenetics, pathogenic mechanisms, virology, carcinogenesis, somatic cell genetics. *Prerequisite:* Permission of instructors. Four hours. Lecture and Laboratory. T. Moehring.

211 Molecular Genetics I. Analysis of organization, replication, expression of genetic material in procaryotes. Standard methods of bacterial and bacteriophage genetics, including the fundamentals of recombinant DNA technology. Recommended prerequisite for **Molecular Genetics II** (see Botany 252). *Prerequisite:* Permission of instructor. Three hours. Novotny.

220 Clinical Microbiology. Comprehensive study of human pathogenic microorganisms and their disease states in the human. Collecting, handling specimens, pathogenic bacteriology, medical mycology, virology. Laboratories: practical experience in handling, identifying pathogens. *Prerequisite:* Microbiology 55 or its equivalent. Immunology recommended but not required. Four hours. Fives- Taylor.

223 Immunology. Analysis of immune response: structure, function of immunoglobulins, cytokinetics of immunocompetence, tolerance, ontogeny, phylogeny of adaptive immunity, immunogenetics of transplantation, hypersensitivity states, theories of antibody formation. *Prerequisite:* Permission of instructor. Four hours. Boraker.

225 Virology. Introduction to the nature of viruses, their physical, chemical, and biological characteristics with special reference to cell-virus interaction, viral replication, pathogenesis, viral inhibitors, and oncogenic viruses. *Prerequisite:* Permission of department chairman. Three hours. Staff. Alternate years.

302 Medical Microbiology. Fundamentals of pathogenic microbiology with emphasis on mechanisms of disease production and mechanisms of resistance to infection. The ecologic rather than taxonomic approach is stressed. Primarily for medical students. *Prerequisite:* Departmental permission. Four hours. Staff.

303 Special Problems in Medical Microbiology. Supervised investigations in microbiology. Credit as arranged. Staff.

305 Pathogenic Bacteriology. Studies of major species of pathogenic bacteria, emphasis on mechanisms of disease production, epidemiology, control measures, diagnosis. For graduate students interested in phenomenon of parasitism. *Prerequisite:* Permission of the instructor. Three hours. Stinebring.

381 Seminar. Current problems in medical microbiology. One hour. Staff.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

MEDICAL TECHNOLOGY

Associate Professors Breen, Lachapelle (Chairperson), Reed, and Sullivan; Assistant Professors Baker, Chickering, Ezekiel, and Sowek; Instructor Czerniawski; Clinical Assistant Professor Russell..

The Department of Medical Technology offers a Master of Science degree with emphasis in the preparation of medical technology educators. The student may also concentrate in clinical chemistry, clinical microbiology, or the student may design a program which fulfills his/her needs.

Areas of research and interest: clinical enzymology; anaerobes; streptococcus identification; mycological techniques; hematological techniques; admission criteria; curriculum design.

In addition, various departments and facilities in the College of Medicine and Medical Center Hospital of Vermont offer other opportunities for research.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Undergraduate major in Medical Technology; national certification, minimum of one year's experience as a medical technologist. GRE general (aptitude) score required.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of a two semester, graduate-level course in Biochemistry (equivalent to Biochemistry 301-302).

MINIMUM DEGREE REQUIREMENTS

Medical Technology 381 (two credits), thesis research (six credits); six credits biochemistry lecture, such as Biochemistry 301-302; six credits clinically related sciences; additional approved courses. In addition, a noncredit teaching practicum is required.

COURSES OFFERED

381 Special Topics. Review and discussion of current areas of importance to students in medical technology. The seminar will emphasize administration, clinical pathophysiology and education. Selected topics are presented by the student with occasional supplemental discussions led by faculty members or guests. One hour per semester. Staff.

391 Master's Thesis Research. Credits as arranged. Staff.

MICROBIOLOGY AND BIOCHEMISTRY

Professors Johnstone, Racusen, and Weller; Associate Professor Sjogren; Assistant Professor Currier; Lecturer Husted; Visiting Associate Professor Kent.

Research currently involves the identification and metabolism of plant proteins, microbial chemotaxis and root nodulation, and the role of microorganisms in aquatic environments. Members of our faculty participate in the interdisciplinary Cell Biology Program (see separate listing in this catalogue).

BIOCHEMISTRY PROGRAM

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in chemistry or biology including a year in organic chemistry, with laboratory. Courses in biochemistry, microbiology and physical chemistry are strongly recommended. Satisfactory scores on the GRE (general).

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of one year of study and completion of admission requirements.

MINIMUM DEGREE REQUIREMENTS

Microbiology and Biochemistry 201, 202, 203, 381-384; thesis research (10-15 hours).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Same as admission for Master of Science degree plus physical chemistry, courses in cellular and molecular biology, mathematics and physics suitable for student's program.

REQUIREMENTS FOR ADVANCEMENT CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Completion of a full year of graduate study and residency at the University of Vermont. One year of laboratory courses in molecular or cellular biology; approval of the Student's Studies Committee and the Graduate College Dean. A reading knowledge of one foreign language, i.e. French, German, or Russian, and satisfactory completion of admission requirements.

MINIMUM DEGREE REQUIREMENTS

Biochemistry 301-302, 303; advanced courses in chemistry (six hours); additional course work as determined by Student's Studies Committee; participation in biochemistry seminar throughout residency; doctoral dissertation research (20-35 hours). This Ph.D. program is co-sponsored with Biochemistry (College of Medicine).

MICROBIOLOGY PROGRAM

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE MASTER OF SCIENCE

An undergraduate major in biological science, including several courses in microbiology and a year of organic chemistry. Satisfactory scores on the GRE (aptitude). A course in biochemistry is recommended strongly as is an indication

of interest in the department program.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Based upon undergraduate record to prior experience, some individuals may be accepted to candidacy upon admission to the program. For others, one year of satisfactory graduate study in this department is required.

MINIMUM DEGREE REQUIREMENTS

Microbiology and Biochemistry 381-384, Medical Microbiology 220; thesis research (10-15 hours).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Same as for admission for the Master of Science degree plus mathematics and physics suitable for the student's program.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

A full year of graduate study at the University of Vermont, approval by the Student's Studies Committee and the Graduate College Dean. A reading knowledge of one foreign language, i.e. French, German, or Russian.

MINIMUM DEGREE REQUIREMENTS

Medical Microbiology 205; the balance of courses from medical microbiology, microbiology and biochemistry, biochemistry, botany and zoology according to student's need as determined by a studies committee; participation in microbiology seminars throughout residency; doctoral dissertation research 20-35 hours. This program is co-sponsored with Medical Microbiology.

COURSES OFFERED

201 General Biochemistry. Broad coverage of biochemistry including principles of analytical biochemistry. *Prerequisite:* Chemistry 42 or 141. Three hours and Lab (one hour) as MCBI 210. Offered each semester.

202 Advanced Biochemistry. A study of metabolic cycles with emphasis on research methods involving radioisotopes and chromatography. *Prerequisite:* 201 or 203 or permission of the instructor. Three hours and Lab (one hour) as MCBI 211. Currier.

203 Molecular Biology. The structure and biological function of nucleic acids, proteins, and enzymes. Emphasis is on optical, electrophoretic, and ultracentrifugal methods. *Prerequisite:* A semester of physical chemistry or permission of instructor. Three hours and Lab (one hour) as MCBI 212. Weller.

220 Environmental Microbiology. The activities of microorganisms, primarily bacteria, in air, soil, and water. *Prerequisite:* A previous course in microbiology. Three hours and Lab (one hour) as MCBI 221. Sjogren. Alternate years, 1983-84.

254 Microbial Biochemistry. The chemical composition and metabolism of microbial cells. *Prerequisites:* 55, 201, or permission of instructor. Three hours and Lab (one hour) as MCBI 255. Sjogren. Alternate years, 1984-85.

295 Special Topics. Lectures, readings, laboratory studies, or field trips. Format and subject matter at the instructor's discretion. Spring, summer, and fall. *Prerequisite:* Departmental permission. Credit to be arranged.

301 Special Problems. *Prerequisite:* Departmental permission. Credit as arranged.

381-384 Seminar. A topical seminar with discussion of assigned and collateral reading. Required of graduate students. One hour.

391 Master's Thesis Research. Credit as arranged.

491 Doctor's Thesis Research. Credit as arranged.

MUSIC (See Page 176)

NATURAL RESOURCES

Three Master of Science degree programs are offered through the School of Natural Resources. One of these degrees is in the Department of Forestry; one in Wildlife and Fisheries Biology; and the third is the interdisciplinary Natural Resource Planning program.

FORESTRY

Professors Hannah, Reidel, and Whitmore; Associate Professors Armstrong, Bergdahl, DeHayes, Donnelly, Forcier (Acting Director) and Newton; Lecturer Turner; Extension Associate Professor Bousquet; Extension Assistant Professor McEvoy.

The goal of this Master of Science program is to provide graduate students with initial training as forest scientists or the opportunity to further their knowledge and proficiency in some specialized aspect of forest resource management. The faculty has research interests which span the broad areas of biometry, ecology and silvics, genetics, economics and management, pathology, policy and administration, silviculture, and utilization. A student's thesis research is often an integral part of on-going research projects in the Department.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE (FORESTRY)

Successful completion of a four-year forestry curriculum or a strong background of specified (by the Department) undergraduate forestry courses. Satisfactory scores on the Graduate Record Examination, general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS

Advanced forestry and related courses (15-24 hours); thesis research (six to 15 hours), and oral defense.

NATURAL RESOURCE PLANNING

Professors Cassell, and Reidel; Associate Professors Forcier (Acting Director), Hirth, Gilbert, Lindsay, Manning and Newton; Assistant Professor Hendrix; Research Assistant Professor Clausen; Extension Instructor Marek.

This interdisciplinary program prepares students for professional careers with public and private organizations engaged in various aspects of natural resource planning. Theoretical and practical education is offered in planning the location,

development, and coordination of resource uses, services, and related facilities.

In addition to faculty members from the School of Natural Resources, there is participation by faculty members from other departments, including Agricultural and Resource Economics, Civil Engineering, Geography, and Sociology.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE (NATURAL RESOURCE PLANNING)

Undergraduate degree in an appropriate field and satisfactory scores on the Graduate Record Examination, general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS

Plan A: At least 24 hours in individually prescribed courses numbered above the 200 level and six hours of thesis research, for a total of 30 hours. Thesis preparation and defense required.

Plan B: Completion of 36 hours of advanced courses and independent study prescribed by the candidate's faculty studies committee. A planning project which must be defended is included in the 36 hours.

Irrespective of the plan chosen, students in the Natural Resource Planning Program usually are in residence for two years.

WILDLIFE AND FISHERIES BIOLOGY

Associate Professors Capen, Forcier (Acting Director), Hirth and LaBar; Assistant Professor Fuller.

The Master of Science program is designed to provide the vehicle for the wildlife or fisheries biologist to develop his/her research abilities and pursue a specialized course of study. Current areas of research emphasis include applied avian ecology; ecology of wetlands; waterfowl and furbearers; behavioral ecology; big game management; and freshwater fisheries ecology.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE (WILDLIFE AND FISHERIES BIOLOGY)

Undergraduate degree in Wildlife and Fisheries Biology or Management or in the Biological Sciences. Satisfactory scores on the Graduate Record Examination, general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS

At least 15 hours of course work accepted for credit in Wildlife and Fisheries Biology and related fields; thesis research carrying a maximum of 15 credits and an oral defense. The Studies Committee may require additional undergraduate preparation without credit toward the degree in instances of perceived deficiency.

COURSES OFFERED

FORESTRY

205 Mineral Nutrition of Plants. See Plant and Soil Science.

221 Forest Soils and Site Relations. Forest soils from an ecological perspective. Profile development, physical properties, roots, water relations, nutrient cycling, topographic factors, site quality and the potential to produce biomass. *Prerequisites:* 120, Plant and Soil Science 161 and permission. Three hours. Hannah. Alternate years, 1984-85.

222 Advanced Silviculture. Scientific bases for selected silvicultural practices. *Prerequisite:* Permission of instructor. Three hours. Hannah. Alternate years, 1983-84.

229 Water Relations of Plants. Terminology and measurement of soil moisture. Absorption, transport, and transpiration by plants. Effects of water excesses and deficits. *Prerequisite:* Permission. Three hours. Donnelly, Botany and Plant and Soil science staff. Alternate years, 1983-84.

231 Integrated Forest Protection. Integration of concepts of forest protection using a holistic ecological approach to forest pest management. Detection, population dynamics, evaluation, prediction and pest management considerations. *Prerequisites:* 132, 133, 134 or permission. Three hours. Bergdahl. Alternate years 1984-85.

242 Advanced Forest Biometry. Advanced principles of estimation, prediction, inventory and evaluation of forest resources. Use of system analysis techniques in natural resource management. *Prerequisite:* 140 or permission of instructor. Three hours. Newton. Alternate years, 1984-85.

252 Forest Valuation. Principles of valuation of forest land, growing stock, and other forest resources. *Prerequisites:* 272 and 151 or concurrent enrollment. Two hours. Armstrong.

254 Advanced Natural Resource Policy. Advanced seminar in natural resource policy; with emphasis on current issues in forest policy. *Prerequisites:* Graduate or advanced undergraduate standing; 251 or permission of the instructor. Three hours. Reidel.

271 Applied Forest Management Decision Theory. Operations research procedures in forest management. Management strategies for industrial and public forestry operations. *Prerequisites:* 123 and 140. Three hours. Armstrong.

282 Seminar in Research Planning. (See Natural Resources 282) One hour. Newton and Manning.

285 Advanced Special Topics. Advanced special topics courses or seminars in forestry beyond the scope of existing formal courses. *Prerequisites:* Graduate or advanced undergraduate standing and permission of instructor. Credit as arranged.

324 Advanced Forest Genetics. Discussion of the adaptive and physiological nature of genetic variation in forest trees. Analysis of procedures, results, and interpretations of selected forest genetics research. *Prerequisites:* STAT 211; FOR 124 or equivalent and permission. Three hours. DeHayes. Alternate years 1983-84.

385 Selected Problems in Forestry. Advanced readings, or a special investigation dealing with a topic beyond the scope of existing formal courses. *Prerequisite:* Graduate standing and permission of instructor. Credit as arranged.

391 Master's Thesis Research. Credit as arranged.

NATURAL RESOURCES

235 Legal Aspects of Planning and Zoning. Comparison of Vermont planning and zoning law with that of other states. Case studies in planning, zoning and land use controls. *Prerequisite:* Senior standing. Three hours.

240 Wilderness and Wilderness Management. (See Recreation Management 240). Three hours. Manning. (Not offered during academic year 1983-84.)

244 Quantitative Assessments of Natural Resources. Principles associated with inventorying selected natural resources. Survey of measurement and estimation techniques for land, timber, wildlife, fisheries, surface water and recreation. *Prerequisite:* One course in statistical methods, one 200-level natural resource course and permission of instructor. Three hours. Newton.

254 Advanced Natural Resource Policy. (See Forestry 254.) Three hours. Reidel.

272 Environmental Impact Assessment. Comprehensive perspective on methods and problems of assessing environmental and social impacts arising from natural resource management. *Prerequisite:* Senior standing. Three hours. Hendrix.

275 Natural Resources Planning Theory and Techniques. Consideration of historical and theoretical roots of resource planning. Development of some skills mandated of natural resource planners. *Prerequisite:* Senior Standing. Three hours. Hendrix.

276 Water Quality for Natural Resource Managers. Study of major contaminants and their behavior in surface and groundwater systems. Field methods for water quality analysis. Extensive field project. *Prerequisites:* Senior standing and permission. Three hours. Cassell.

278 Water Resources: Analysis, Planning and Management. Study of the physical, chemical and biological phenomena in rivers, streams and lakes. Concepts of water resources modeling, planning and management. *Prerequisite:* Permission of instructor. Three hours. Cassell.

282 Seminar in Research Planning. Discussions on the planning and activities with graduate projects and research. Students prepare and present a formal study proposal. *Prerequisites:* One hour. Newton, Manning.

285 Advanced Special Topics in Natural Resource Planning. Advanced special topics in natural resource planning beyond the scope of existing formal courses. *Prerequisites:* Graduate of Senior Standing and permission of instructor. Credit as arranged.

380 Seminars in Natural Resources. Presentation and discussion of advanced problems, research and current topics in natural resources by faculty, graduate students and outside guest speakers. *Prerequisites:* Graduate student standing in Natural Resources. 0.5 credits/semester, maximum two credits. School of Natural Resources faculty (Chairman of Curriculum Committee).

391 Master's Thesis/Project Research. Credit as arranged.

RECREATION MANAGEMENT

225 Economics of Outdoor Recreation and Tourism. A socioeconomic analysis of recreation and tourism as an industry. Emphasis on regional, state and community impact. *Prerequisites:* Economics 11, 12 or Resource Economics 61. Three hours. Gilbert.

235 Outdoor Recreation Planning. The planning of large wildland areas for outdoor recreation. Emphasis on the planning process relative to the leisure time use of natural resources. *Prerequisites:* 150 or Forestry 140; PSS 161 or Geology 1. Three hours. Lindsay.

240 Wilderness and Wilderness Management. History, philosophy and management of wilderness, national parks and related areas. *Prerequisites:* RM 235 or permission. Three hours. Manning. (Not offered during academic year 1983-84.)

WILDLIFE AND FISHERIES BIOLOGY

232 Icthyology. Biology of fishes. Study of the structure and function of systems; behavior and ecology of modern fishes. *Prerequisites:* Zoology 104 or 219 or equivalent, Wildlife and Fisheries Biology 161. Three hours. LaBar.

264 Nongame Wildlife Management. Selected topics which emphasize nongame birds and mammals: endangered species, vertebrate pests, urban wildlife, specialized survey and management practices. *Prerequisite:* 174. Three hours. Capen.

271 Wetlands Ecology and Marsh Management. Structure and dynamics of natural and manmade marsh systems, emphasis on applied ecology, freshwater habitats and their wildlife populations. *Prerequisites:* 174 or permission. Three hours. Fuller.

273 Wetlands Ecology and Marsh Management. Qualitative and quantitative assessment of marsh habitats and wildlife populations, emphasizing management of waterfowl and furbearers. Technical paper required. One weekend trip. *Prerequisites:* 150; previous or concurrent enrollment in 271. One hour. Fuller.

274 Uplands Wildlife Ecology. Integration of ecological principles, wildlife

biology, land use, and human dimensions in wildlife. Emphasis on developmental and maintenance of wildlife habitat, and population regulation of uplands species. *Prerequisites:* Courses in ornithology and mammalogy, Wildlife and Fisheries Biology 150, 174. Four hours. Hirth.

275 Wildlife Behavior. Behavior and social organization of game and nongame species as they pertain to population management. *Prerequisites:* One year of biology, an ecology course, 74 or 174 recommended. Three hours. Hirth.

285, 286 Advanced Special Topics. Credit variable.

387, 388 Graduate Special Problems. Advanced readings or special investigation dealing with a topic beyond the scope of existing formal courses or thesis research, culminating in an acceptable paper. *Prerequisite:* Permission of instructor. Credit as arranged.

391 Master's Thesis Research. Credit as arranged.

RECOMMENDED COURSES IN OTHER COLLEGES

AREC 222 Natural Resources Evaluation

AREC 233 Rural Planning

AREC 234 Practicum in Rural Planning

CE 230 Urban Planning Techniques

CE 231 Urban Planning Analysis

CE 232 Community Design

GEOG 287 Spatial Analysis I

SOC 205 Rural Communities in Modern Society

SOC 207 Community Organization and Development

OBSTETRICS AND GYNECOLOGY (See Page 176)

ORTHOPAEDIC SURGERY (See Page 176)

PATHOLOGY

Professors Clemmons, Craighead (Chairman), Howard, Korson, Perl, Stark, and Trainer; Associate Professors MacPherson, E. McQuillen, J.B. McQuillen, Tindle, and Winn; Assistant Professors Bovill, Hardin, Lapenas, Lee, Morrow, Mossman, and Sharp; Research Assistant Professors Adler, Allen, Heintz, and Huber.

Research interests are in the fields of anatomic, clinical, and experimental pathology. Current studies include histochemistry, connective tissue pathology and biochemistry, electron microscopy, neoplasia, teratology, immunopathology, virology, and lung diseases.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory undergraduate or graduate course work in chemistry and the biological sciences. Microbiology and immunology are also recommended but not required. Satisfactory scores on the Graduate Record Examination, general (aptitude) section. Persons interested in a Ph.D. program may wish to consider the interdisciplinary program in Cell Biology in which Pathology participates.

MINIMUM DEGREE REQUIREMENTS

Anatomy 311 (three hours), Pathology 305 (three hours), Biochemistry 301-302 (six hours); additional approved courses; thesis research (six to 15 hours).

COURSES OFFERED

301 General Pathology. A study of the processes of injury, repair, neoplasia, degeneration, etc., as they affect cells, tissues, and the human patient. For medical

students. *Prerequisite:* Departmental permission. Three hours. Staff.

302 Systemic Pathology. Introduction to diseases, pathologic processes with particular reference to their effects on various organ systems. Instruction in clinical laboratory medicine is correlated with work in systemic pathology. *Prerequisites:* 301 and departmental permission. Eight hours. Staff.

305 Pathobiology of Disease. Basic mechanisms of disease in general context of their morphologic effects on cells and tissues. Overview serving as fundamental basis of research pathology. *Prerequisites:* Graduate status. Histology and biochemistry required. Microbiology highly recommended. Four hours. Staff.

391 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.

395 Special Topics in Pathology: Immunopathology. An indepth analysis is planned into the role of the immune system in disease processes. Discussions will center on current and controversial areas of immunopathology. *Prerequisites:* Immunology, (Medical Microbiology 223) and Pathology 305, or Departmental permission. Two hours. Staff.

PHARMACOLOGY

Professors J. Bevan (Chairman), Gans, Jaffe, Krakoff, and McCormack; Associate Professors R. Bevan, Newman, Reit and Scollins; Assistant Professors Ershler, Hacker, and Stewart; Visiting Professor Maxwell.

Research interests of the staff include: regulation of cardiovascular function and causes of hypertension; pharmacokinetics and pharmacodynamics of antiparasitic and anticancer drugs; synthesis, properties and structure-activity relationships of biologically active nitrogen heterocyclic compounds; mechanisms of adaptation to chemical injury in mammalian liver; functions of neurohumoral substances in synaptic transmission and microcirculatory regulation.

A pre- and post-doctoral training program in the clinical pharmacology of anticancer drugs is offered in cooperation with the Vermont Regional Cancer Center.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREES OF MASTER OF SCIENCE AND DOCTOR OF PHILOSOPHY

Year courses in Biology, Organic Chemistry, Physics, Analytic Geometry and Calculus; Physical Chemistry and/or a reading knowledge of one foreign language may be additional prerequisites, depending on the requirements of the research supervisor; acceptable scores on the general (verbal, quantitative) and subject (advanced) sections of the Graduate Record Examination.

MINIMUM REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE

Pharmacology 301, 302, 303, 372, 381, 391; supporting courses in Biochemistry and Physiology.

MINIMUM REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

Physiology and Biophysics 301; Biochemistry 301-302. Pharmacology 301, 302, 303, 328, 372, 381, 491; Biometrics and Applied Statistics 308.

COURSES OFFERED

272 Toxicology. The biology of environmental intoxicants and of drug abuse. Ecologic and physiologic consequences of the dissemination of agricultural, industrial and medicinal chemicals. *Prerequisites:* Organic chemistry and background in biology. Open to undergraduates. Three hours. Gans.

301 Medical Pharmacology. The chemical and biological properties of drugs. *Prerequisite:* Departmental permission. Six hours. Staff.

302, 303 Pharmacological Techniques. Experiments conducted under supervision in the areas of drug metabolism, modes of drug action, physicochemical properties of drugs, bioassay, and toxicology. *Prerequisite:* Departmental permission. Two hours, by arrangement. Staff.

328 Introduction to Medicinal Chemistry. Important classes of drugs are surveyed. Emphasis is placed on relationships between physiochemical properties and pharmacologic activity; synthetic aspects are considered. *Prerequisites:* Chemistry 131-132. Open to undergraduates with permission of instructor. Three hours. McCormack.

372 Special Topics. Topics of current interest and importance in pharmacology are considered in depth through presentations by staff, students and visiting scientists. *Prerequisite:* Departmental permission. Credit variable one to three hours. Staff.

373 Readings in Pharmacology. Intensive directed reading in one area of pharmacology. Pharmacology students must choose a topic outside thesis research area. Term paper and seminar on selected topic required. *Prerequisite:* Departmental permission. Two hours, by arrangement. Staff.

381 Seminar. Current developments in pharmacology are presented for discussion by students. *Prerequisite:* Departmental permission. One hour. Staff.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

PHILOSOPHY (See Page 176)

PHYSICS

Professors Arns, Brown, Crowell, Detenbeck, Krizan, Lambert (Chairperson), Nyborg, and Scarfone; Associate Professors Rankin, and Sachs; Assistant Professor Spartalian; Research Associate Professor Miller.

The Department of Physics offers experimental and theoretical opportunities for research in the fields of astrophysics, biological physics, solid state physics, and the physics of materials.

Astrophysical research in the Department is in the general area of experimental radio astronomy, particularly of pulsars and of the interstellar medium. Observations are carried out using the major instruments of the U.S. National Observatories and generally involve computer analysis and interpretation.

In the field of biophysics the experimental projects are concerned with the application of Mossbauer spectroscopy, with biophysical and medical ultrasound and with light scattering. Mossbauer experiments are carried out to determine the electronic structure at the active site of iron-containing proteins and enzymes. In biophysical ultrasound the research is aimed at understanding the physical principles involved when ultrasound interacts with and perturbs living systems. Medical applications include ultrasonic tissue characterization, ultrasonic thermometry, perfusion monitoring, and analysis of the geometry of

brain function. The scattering of highly coherent laser light is being applied to measurements of the mobility of single-cell organisms and to other time-dependent changes in their structures. There are theoretical research programs devoted to both the interpretation of the ultrasonic work and to the applications of statistical mechanics and quantum mechanics to fundamental properties of biomacromolecules and biomembranes.

Materials research includes experimental programs concerned with the interaction of gas molecules with metal surfaces using ultra high vacuum, radiotracer, photoelectron emission, and thin film techniques. The mechanisms of photoelectron emission, and the general area of electromagnetic interactions in metals are being investigated using vector photoelectric methods in near and far ultraviolet regions of the spectrum. Additional research involves the optical properties of solids and vapor streams as well as device physics, and the properties of semiconductor-oxide or electrolytic interfaces.

Theoretical and computational research programs in condensed matter physics are concerned with the electronic, lattice dynamical, magnetic and superconducting properties of a variety of materials including transition and rare earth metals, amorphous metals, liquid metals, ordered and disordered alloys, mixed crystals, and heavily doped elemental and compound semiconductors. The analytical and numerical methods of self-consistent band theory, multiple scattering theory, many-body theory, and Green's function formalism are some of the general approaches used in this research. In addition, theoretical work is conducted on the interactions between intense laser radiation and solids in such processes as heating, melting, vaporization, and plasma production.

Theoretical research in the statistical mechanics of plasmas, quantum field theory and particle physics, multiple-time scale perturbation theory, relativity, and many-body theory is carried on, as well.

Some of the above projects are carried out with the active cooperation of faculty in other science departments and opportunities exist for collaborative research with such other departments and groups of the University as Chemistry, Physiology and Biophysics; Cell Biology, Electrical and Mechanical Engineering, Medical Radiology, and the Academic Computer Center.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Undergraduate majors in Science, Engineering, or Mathematics are considered for admission to the program. Satisfactory scores on the Graduate Record Examination (general and subject section) are required.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Physics 211, 213, and 273; two additional semester courses in physics above the sophomore level; two semester courses in mathematics above the sophomore level.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

A total of 30 credit hours including a minimum of six hours of thesis research and at least nine hours of Physics courses numbered over 300.

The department also offers programs leading to the degrees of Master of Science in Engineering Physics, Master of Arts in Teaching, and Master of Science for Teachers of Physical Science. As a participant in the Materials Science program, the department sponsors candidates for the degrees of Master of Science and Doctor of Philosophy in Materials Science. Details are available elsewhere in the catalogue and also from the Physics Department.

COURSES OFFERED

201, 202 Experimental Physics. Experiments in classical and modern physics. Each student selects laboratory experiments appropriate to his background and interests. *Prerequisites:* 16 or 128, Mathematics 121 or 123; junior standing. Three hours per semester, four semesters maximum.

211 Mechanics. Newtonian dynamics of particles and systems of particles. Extensive use is made of descriptive, analytical, and approximational techniques. *Prerequisites:* 16 or 24; Mathematics 121 or 123. Three hours.

213 Electricity and Magnetism. Theory of electrostatic fields, and magnetic fields of steady currents. Electrical and magnetic properties of matter and electromagnetic energy relationships. Vector analysis developed as necessary. *Prerequisites:* 16 or 25; Mathematics 121 or 123. Three hours.

214 Electromagnetism. An introduction to time-dependent electromagnetic fields. Maxwell's equations in space and matter. Electromagnetic waves and radiation. *Prerequisite:* 213. Three hours. Alternate years, 1983-84.

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. *Prerequisites:* Chemistry 2; Mathematics 121 or 123; experience in applying differential equations. Departmental permission required. Four hours. Alternate years, 1982-83.

242 Introduction to Solid State Physics. Introduction to crystal structures, reciprocal lattices, lattice vibrations. Thermal properties of solids and free electron theory of metals and semi-conductors. Elementary band theory. *Prerequisite:* 128. Three hours. Alternate years, 1982-83.

254 Atomic and Nuclear Physics. Phenomenological study of electronic structure of atoms, including vector model and various coupling modes. Development of quantum theory. Structure of the nucleus and properties of elementary particles. *Prerequisite:* 211. Three hours. Alternate years, 1983-84.

258 Relativity. Development of Einstein's theory of special relativity. Lorentz transformation, time dilation, length contraction, mass variation, relative velocities. Introduction to four dimensional space. Concepts of general relativity. *Prerequisite:* 128. Three hours. Alternate years, 1983-84.

264 Introduction to Elementary Particles. Theoretical and experimental aspects of elementary particles including their properties, classification schemes, symmetries, conservation laws, fundamental interactions, models of particle structure, special topics as time allows. *Prerequisites:* Physics 128, 213. Three credit hours.

265 Therman Physics. Basic concepts of thermodynamics including equilibrium conditions in homogeneous and heterogeneous systems. Introduction to kinetic theory and statistical mechanics. *Prerequisites:* 128 and Mathematics 121 or 123. Three hours. Alternate years, 1982-83.

273 Quantum Mechanics I. Introduction to nonrelativistic quantum mechanics. Schroedinger equation and applications to simple systems. *Prerequisites:* 128 and 211. Three hours.

295, 296 Special Topics. Lectures, readings, or laboratory studies. Format and

subject matter at the instructor's discretion. *Prerequisite:* Permission of instructor. One, two, or three credit hours.

301 Mathematical Physics. Introduction to basic mathematical methods of theoretical physics; vector and tensor analysis, partial differential equations, orthogonal functions, complex variables and variational techniques. *Prerequisites:* 211 and 214. Three hours. Alternate years, 1983-84.

311 Advanced Dynamics. Classical Mechanics presented as the basis of the concepts and methods of modern physics. Variational, Lagrangian and Hamiltonian formulations, canonical transformations, continuous systems. *Prerequisite:* 211. Three hours. Alternate years, 1982-83.

313 Electromagnetic Theory. Development of Maxwell's theory of electromagnetism with emphasis on its physical basis and the modes of mathematical description. *Prerequisite:* 214. Three hours. Alternate years, 1982-83.

321 Seminar in Theoretical Physics. For research students interested in pursuing topics of general and departmental research interest in theoretical physics. *Prerequisite:* Permission of instructor. Offered as occasion warrants. Credit as arranged.

323 Seminar in Contemporary Physics. Topics of current interest in physics to be offered as student and faculty interest warrant. May be repeated for credit with departmental approval. *Prerequisite:* Permission of instructor. Credit as arranged.

331 Seminar in Biological Physics. For research students in the field of biological physics. Lectures, reports and directed readings related to the research of the department and the field generally. May be repeated for credit with departmental approval. *Prerequisite:* Permission of instructor. Credit as arranged. Offered as occasion warrants.

341, 342 Solid State Physics. Introduction to crystal symmetry and the reciprocal lattice. Crystal binding and lattice vibrations. Thermal, electrical, and magnetic properties of solids, free electron theory of metals, and band theory. *Prerequisites:* 214, 265, and 273 or their equivalents; permission of instructor. Three hours. Alternate years, 1983-84.

351 Seminar in Physics of Materials. For research students in the field of the physics of materials. Lectures, reports and directed readings related to the research for the department and the field generally. May be repeated for credit with departmental approval. *Prerequisite:* Permission of instructor. Credit as arranged. Offered as occasion warrants.

362 Quantum Mechanics II. Mathematical and physical foundations of nonrelativistic quantum mechanics from the unifying point of view of Dirac. Symmetry operations and the algebraic structure of quantum mechanics are emphasized. *Prerequisite:* 273. Four hours. Alternate years, 1982-83.

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:* 265, 273. Three hours. Alternate years, 1983-84.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

The following courses are offered as the occasion warrants by members of the Department. For descriptions see the Department Chairperson.

314 CLASSICAL ELECTRODYNAMICS

343 ADVANCED SOLID STATE PHYSICS

373 RELATIVISTIC QUANTUM MECHANICS

374 QUANTUM FIELD THEORY

376 STATISTICAL MECHANICS

PHYSIOLOGY AND BIOPHYSICS

Professors Alpert (Chairman), Gibbons, Hendley, Lowe, McCrorey; Associate Professors Halpern, Webb; Assistant Professors Evans, Hamrell, Kimura, McLaughlin, Patlak; Research Assistant Professors Hultgren, Litten, Maughan, Mulieri, Stirewalt.

Specific areas of interest include mechanics and energetics of cardiac and skeletal muscle; respiration; properties of vascular and bronchial smooth muscle; cardiac electrophysiology and excitation-contraction coupling; molecular basis of contraction of skeletal and cardiac muscle; neurochemistry of brain function; effects of insulin on skeletal muscle; reproductive physiology; protein turnover; synaptic physiology and pharmacology; cholinergic and adrenergic receptor function; changes in cation transport associated with human hypertension; and electrophysiology of the central nervous system. Opportunities exist in the Department of Physiology and Biophysics for multi-disciplinary studies in neurobiology, pulmonary biology, cardiovascular biology, cell biology, and biological motility. For example, coordinated studies are underway: on the biochemistry, mechanics, energetics, and excitation-contraction coupling of muscle from hypertrophied hearts; and, on the neurochemistry and central nervous system regulation of the circulatory system, and vascular smooth muscle properties in hypertensive rats.

Preference in admission and awarding financial support will be given to Ph.D. applicants.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory performance on general (aptitude) section of Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Year courses in Biology, Organic Chemistry, and Physics. These requirements must be completed by the end of the first year of residency.

MINIMUM DEGREE REQUIREMENTS FOR MASTER OF SCIENCE

Physiology and Biophysics 304-305; 308; 323; Biochemistry 301-302; other graduate courses as arranged (three hours minimum); thesis research (six to 15 hours).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory performance on general (aptitude) section of Graduate Record Examination. A master's degree is not a prerequisite for the Ph.D. degree.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Biology, one year; Chemistry, organic and physical; Physics, one year; Mathematics, through calculus. A reading knowledge of French or German is recommended. These requirements must be completed by the end of the first year of residency.

MINIMUM DEGREE REQUIREMENTS

Physiology and Biophysics 304-305, 308; 323; Biochemistry 301-302; additional approved courses amounting to at least 40 hours, 16 of which must be in the Department; dissertation research, minimum 35 hours; language requirement is flexible and will be determined for each individual after consulation with the Studies Committee.

COURSES OFFERED

301 Medical Physiology and Biophysics. Function in the whole human organism, and at the cellular, tissue, and organ levels, considered biologically and physically. *Prerequisite:* Permission of department chairman. Eight hours. Staff.

302 Neuroscience. A correlated presentation of the neuroanatomy and neurophysiology of mammalian CNS. Same course as Anatomy 302. *Prerequisite:* Permission of instructor. Four hours. Anatomy and Physiology Staff.

303 Special Problems in Physiology. Various problems are covered by means of lectures, reports and directed reading. *Prerequisites:* 304-305; permission of department chairman. Credit as arranged. Staff.

304 Physiology and Biophysics. Cellular Biophysics with emphasis on the underlying mechanisms of excitation, membrane transport, and muscular contraction. Current research directions discussed. *Prerequisites:* Permission. Four hours. Dr. Patlak (Fall).

305 Physiology and Biophysics. Organ systems and mechanisms for maintaining homeostasis. Specific areas of controversy examined. *Prerequisites:* Permission. Four hours. Drs. Exans and McLaughlin (Spring).

308 Biometrics and Applied Statistics. Introduction to the rational use and evaluation of statistical methods in planning experiments and interpreting biological data. Biometrics laboratory included. Course limited to twelve students. *Prerequisites:* Math 110 or equivalent, and permission of instructor. Five hours. McCrorey.

309 Synaptic and Conducting Membranes. The mechanisms of synaptic transmission and nerve and muscle conduction will be explored with particular emphasis on molecular structure and function. *Prerequisites:* 304-305 and 302, Biochemistry 301, 302, permission of instructor. Three hours. Webb. Alternate years, 1984-85.

310 Molecular Basis of Biological Motility. Molecular basis of muscle contraction, biological movement. Problems of energetics, mechanics, chemistry of biological motility. Special emphasis on contraction of skeletal muscle. Lectures and conferences. *Prerequisites:* 304-305, 302; Biochemistry 301, 302; permission of instructor. Three hours. Alpert and/or staff. Alternate years, 1983-84.

313 Seminar on Endocrine Physiology. The course will be devoted to a study of current problems in endocrine research with major emphasis on the molecular mechanism of action of hormones. *Prerequisites:* 304-305 or Endocrinology 271; Biochemistry 301-302; permission of instructor. Three hours. Low. Alternate years, 1983-84.

317 Advanced Neuroscience. Current multidisciplinary approaches to the study of brain and behavior, particularly systems neurophysiology and transmitter neuropharmacology. Students pursue areas of special interest. *Prerequisite:* 302, Psych. 222, or permission. Three hours. Hendley and/or staff. Alternate years, 1984-85.

323 Principles and Elements of Biomedical Instrumentation. Instrument methodology for biologically trained researchers. Topics: basic electrophysics; transducers; concepts and manipulation of bioelectric and other signals; physiological instrument systems. Laboratory supports theoretical ideas. *Prerequisite:* Permission of instructor. Five hours. Halpern, staff. Alternate years, 1984-85.

381 Seminar. Presentation and discussion by advanced students and staff of current developments and research in the field. *Prerequisite:* Permission of department chairman. One hour per semester.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

PLANT AND SOIL SCIENCE

Professors Bartlett, Boyce, MacCollom, Wiggans, and Wood; Associate Professors Magdoff, Murphy, Parker, and Pellett; Extension Professor Way; Extension Associate Professors Costante, Gotlieb (Chairman); Extension Assistant Professors Nielsen and Perry; Lecturers Margolis, Villamil.

Current research projects are concerned with the solution of horticultural and agronomic problems with special emphasis on environmental physiology, soil chemistry, plant nutrition, and pest management. Areas of research include winter hardiness of fruits, and woody and herbaceous ornamentals; cultural and environmental interrelationships as they affect plant growth, crop adaptation, and variety; pasture renovation and marginal land utilization; crop establishment and soil productivity; soil chemistry of the rhizosphere; behavior of nitrogen in the soil; nutrient availability to plants; agricultural waste management; temperature effects on soil water retention and transmission; biological control of insects, disease, and weeds; integrated pest management for control of insects, diseases and weeds. A student's thesis research will be an integral part of the on-going research efforts of the department.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in an appropriate agricultural, environmental, biological, or physical science. Satisfactory scores on the Graduate Record Examination, general (aptitude) section.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of one academic year of graduate study in the Department of Plant and Soil Science, a written comprehensive examination.

MINIMUM DEGREE REQUIREMENTS

Eighteen to 22 hours in Plant and Soil Science and closely related fields; satisfactory participation in seminars during residency; thesis research (eight to 12 hours).

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

An undergraduate major in an appropriate agricultural, environmental, biological, or physical science. Satisfactory scores on the Graduate Record Examination, general (aptitude) section.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory completion of two academic years of graduate study in the Department of Plant and Soil Science at the University of Vermont. With the approval of the Dean of the Graduate College and the Department of Plant and Soil Science, a master's degree may be accepted in partial fulfillment of this requirement.

Satisfactory completion of a written and oral qualifying doctoral examination as prescribed by the Department.

A reading knowledge of a modern foreign language appropriate to the student's specialty. Proficiency in other areas appropriate to the student's specialty may be substituted for the language requirement with the approval of the Studies Committee. This proficiency does not count toward course requirements for the degree.

MINIMUM DEGREE REQUIREMENTS

The course requirements are as follows: a total of at least 40 credit hours of which a minimum of 30 must be taken in Plant and Soil Science and closely related disciplines (e.g. Botany, Chemistry, Forestry, Microbiology and Biochemistry, Geology). Satisfactory participation in seminars during residency is required. All doctoral students must take part in the Department's undergraduate teaching program.

COURSES OFFERED

202 Micrometeorology. Theoretical and practical considerations of the micrometeorological factors that affect plant growth and agricultural practices. *Prerequisite:* 11. Three hours. Alternate years, 1983-84.

205 Mineral Nutrition of Plants. See Botany 205. Alternate years, 1983-84.

207 Water Relations of Plants. See Forestry 229. Alternate years, 1983-84.

210 Soil Erosion and Conservation. General hydrological processes involved in surface runoff and resultant soil erosion; land management techniques for controlling soil and sediment pollution. *Prerequisites:* 161, Math 2 or 9, Chemistry 3. Three hours.

215 Weed Science. Principles and practices of weed science, including weed identification, ecology, reproduction, control, and integrated pest management. *Prerequisites:* 11 and 161. Three hours. Murphy. Alternate years, 1982-83.

221 Tree Fruit Culture. Theory and practice of modern commercial fruit science. Nutrition and cultural responses to various management practices. *Prerequisites:* 11 and 61. Three hours. Boyce.

232 Biological Control of Insect Pests. A survey of the biological agents used in controlling insects and related arthropods, and their application and limitations. *Prerequisite:* An intermediate course in entomology. Three hours. MacCollom. Alternate years, 1982-83.

261 Soil Classification and Land Use. Classification of soils throughout the world as they relate to soil development and land use. Three Saturday field trips. *Prerequisite:* 161 or a total of six hours in ecology, geography or geology. Three hours. Bartlett. Alternate years, 1982-83.

264 Chemistry of Soil and Water. A biologically biased study of the colloidal chemistry of soil and its interfaces with roots, water, and air. *Prerequisites:* 161, two semesters chemistry. Four hours. Bartlett.

266 Soil Physics. Mathematical and physical principles of the soil-water-plant

interaction and its relationship to production and management. *Prerequisites:* 161, Physics 5-6 or Chemistry 1-2. Three hours. Bartlett. Alternate years, 1982-83.

281 Seminar. Presentation and discussion of papers on selected topics of current interest by students and staff. *Prerequisite:* Senior standing. One hour. Staff.

297 Special Topics. Lectures, laboratories, readings, field projects, surveys, or research designed to provide specialized experience in horticulture, agronomy, soils, entomology and integrated pest management. *Prerequisites:* Senior standing and/or permission. One to three hours. Staff.

301 Plant Science Colloquium. Graduate student and staff discussion of current research topics in plant science. One hour. Staff.

302 Soil Science Colloquium. Graduate student and staff discussion of current research topics in soil science. One hour. Staff.

381 Graduate Special Topics. Advanced readings and discussion of horticulture, crops, or soils research literature. Three hours. Staff.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

POLITICAL SCIENCE

Professors Hilberg, Kinnard, Little, Staron, and Wertheimer (Chairperson); Associate Professors Bryan, Mahler, Nelson, Nivola, Pacy, and Simon; Assistant Professors Feldman, Haltom, Holland, Johnson, and Rice.

Research interests of the Department of Political Science and the various library and data processing resources available enable graduate students to undertake research in American political institutions; public law; public policy; political behavior; comparative political systems; international relations; political philosophy and empirical political theory.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES 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, including the subject (advanced) examination in political science.

MINIMUM DEGREE REQUIREMENTS

An approved program of 24 hours in course work, including Political Science 283 and not more than six hours in related fields; thesis research (six hours).

COURSES OFFERED

Admission to the following courses for graduate credit requires the approval of the Department.

211, 212 History of Political Thought. First semester: political thought from Plato to Burke. Second semester: Political thought of the 19th and 20th centuries with emphasis on socialist ideologies from Marx to Marcuse. *Prerequisite:* 31, and 3 hours at the 100 level. Three hours. Staron.

213 Justice and Equality. (Same as Philosophy 242) An examination of contemporary normative theories of distributive justice and equality. *Prerequisite:* 31, and 3 hours at the 100 leel. Three hours. Wertheimer; Kuflik, Sher (Philosophy).

216 American Political Thought. American political thought from the colonial period to recent times. *Prerequisite:* 21, and 3 hours at the 100 level. Background in American history is recommended. Three hours. Simon.

221, 222 Constitutional Law. First semester: emphasis on developing skills of legal analysis. Historical origins and general principles of constitutionalism. Second semester: selected topics in constitutional law. *Prerequisites:* for 221, 121; 221 for 222. Three hours. Haltom.

225 The Judicial Process. Organization, functions, and behavior of state and federal courts. *Prerequisite:* 121. Three hours. Holland.

227, 228 International Law. Principles and applications of public international law. *Prerequisite:* for 227, 51 and 3 hours at the 100 level; for 228, 227. Three hours. Little.

231 The Congressional Process. Organization, procedure, and behavior of the chambers of the U.S. Congress. *Prerequisite:* 21, and 3 hours at the 100 level. Three hours. Nelson.

232 Public Policy Analysis. An examination of the principles for choosing between alternative public policies. A discussion of basic analytical tools, e.g., welfare economics, cost-benefit analysis, operations research. *Prerequisite:* 21, 31, and three hours at the 100 level; Economics 11-12 are strongly recommended. Three hours. Nivola.

233 Issues of Public Policy. An analysis of selected problems of public policy, e.g., welfare, macroeconomic policy, regulation, energy, and housing. *Prerequisite:* 21, 31, and 3 hours at the 100 level; Economics 11-12 are strongly recommended. Three hours. Nivola.

234 The Presidency. The functions and activities of the President and his staff. *Prerequisite:* 21, and 3 hours at the 100 level. Three hours. Johnson.

235 Defense Politics Seminar. Civil-military relations, strategic policy, arms control, defense-industrial complex, defense budget in the post-Vietnam environment. *Prerequisite:* 251. Three hours. Kinnard.

239 American Politics. The politics of decision-making in the American political system. *Prerequisite:* 21, and 3 hours at the 100 level. Three hours. Simon.

241 Public Management. Analysis of major elements of management in public sector (organization, personnel, budgeting) with special attention to problems arising from political imperatives generated by a democratic society. *Prerequisite:* 141. Three hours. Bryan, Johnson.

242 Topics in Public Administration. The political problems of the administrative state. *Prerequisite:* 141. Three hours. Bryan, Johnson.

250 The Craft of Diplomacy. Emphasis on experiences and reflections of diplomatic personalities, supplemented by studies of specialists. *Prerequisite:* 51, and 3 hours at the 100 level. Three hours. Pacy.

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. *Prerequisite:* for 251, 21, 51, and 3 hours at the 100 level; for 252, 51 and 3 hours at the 100 level. Three hours. Kinnard, Hilberg.

256 International Organization. Theory and practice in supranational institutions. *Prerequisite:* 51, and 3 hours at the 100 level. Three hours. Pacy.

261 Urban Government and Politics. An analysis of metropolitan areas in terms of their governments, problems and roles. *Prerequisite:* 21, and 3 hours at the 100 level. Three hours. Nivola.

264 State Administration. Problem in planning, policy development, and program coordination. *Prerequisite:* 141. Three hours. Bryan.

265 Intergovernmental Relations. Problems of the Federal system. National state-local cooperative administration of selected public functions. *Prerequisite:* 21, and 3 hours at the 100 level. Three hours. Bryan, Nivola.

273 Comparative Political Analysis. An intensive examination of selected topics in comparative politics. *Prerequisite:* 71, and 1 course numbered 171-179. Three hours. Mahler.

278 Foreign Policy of the U.S.S.R.. See History 278. *Prerequisite:* 51, and 3 hours at the 100 level. Three hours. Daniels.

283 Methods of Political Science Research. An examination of advanced problems in political methods. Topics include: measurement, correlation, multiple regression, and scaling techniques. *Prerequisite:* 183, or equivalent with permission of instructor. Three hours.

284 Public Opinion: Theory and Research I. (Same as Sociology 241) *Prerequisite:* Political Science 183 (Sociology 100). Three hours. Berkowitz, Danigelis (Sociology).

285 Public Opinion: Theory and Research II. (Same as Sociology 242) An examination of the theories of public opinion. Topics include: attitude formation and change, political ideology, alienation and allegiance, political socialization, tolerance, and political extremism. *Prerequisite:*Political Science 284 (Sociology 241). Three hours. Nixon, Sampson (Sociology).

295, 296 Seminar. Selected topics in political science. *Prerequisite:* As specified. Three hours.

297, 298 Readings and Research. For advanced undergraduate and graduate students. Three hours.

391 through 393 Master's Thesis Research. Credit as arranged.

PSYCHOLOGY

Professor Emeritus Ansbacher; Professors Achenbach, Albee, Burchard, Daniloff, Forgays, Howell, Joffe, Kapp, Lawson, Leitenberg, Musty (Chairperson); Associate Professors Bond, Gordon, Hasazi, Kessler, Leff, Rosen, Yadav; Assistant Professors Barrera, Bouton, Bronstein, Compas, Lobato-Barrera, Lorenz, Miller, Rothblum; Adjunct Associate Professor Copeland; Adjunct Assistant Professors Barasch, Dietzel, Does, Hurley, Schwaber, Stoltenberg, Thompson; Research Assistant Professor S. Burchard; Clinical Assistant Professors Carling, Peyser, Pithers, Solomon; Adjunct Instructors Benay, Reimondi; Clinical Instructor Cioffari.

The Ph.D. program in General and Experimental Psychology began in 1964, and now includes ongoing research in a variety of areas. Details of ongoing research are available on request from the Chairperson, Department of Psychology. Students in this program are involved early in independent research projects. Further information on specific program specialties can be obtained from the Chairperson, Department of Psychology.

The Ph.D. program in Clinical Psychology began in 1969. It stresses early placement in a variety of clinical facilities and emphasizes the development of research and service techniques relevant to clinical problems encountered in those settings. The clinical program is fully accredited by the American Psychological Association, and is now under review as part of the normal reaccreditation process of that association. Further information on the types of clinical facilities and the research interests of the clinical faculty can be obtained from the Chairperson, Department of Psychology.

Applicants should apply for the Ph.D. degree only. Students whose goal is a terminal master's degree are not accepted. The application deadline for admission is February 1. All supporting materials, including GRE scores, must be received by February 1.

In 1974, a small number of students were admitted to the Ph.D. programs on a part-time basis. The intention is to serve neglected Vermont constituencies such as full-time mental health workers with families, and persons with responsibilities at home. The part-time graduate program is not otherwise possible. A justification of the necessity to attend part-time must accompany the candidate's

application. To be eligible for acceptance, applicants must have fulfilled prerequisites and minimum requirements listed below.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF ARTS

A major or its equivalent in undergraduate psychology including courses in statistics and experimental psychology; satisfactory scores on the Graduate Record Examinations, including the subject (advanced) sub-test in Psychology.

MINIMUM DEGREE REQUIREMENTS FOR MASTER OF ARTS DEGREE

Twenty-four hours of psychology courses and seminars, including Psychology 301, 302, 340, 341; thesis research for six credits. The requirement of the specific courses (301, 302, 340, 341) may be exempted by examination. There is no foreign language requirement.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

A major or its equivalent in undergraduate psychology including courses in statistics and experimental psychology; satisfactory scores on the Graduate Record Examinations, including the subject sub-test in Psychology.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

For the General/Experimental Program, satisfactory completion of minimum degree requirements for Master of Arts degree or equivalent; for the Clinical Program, satisfactory performance on the Ph.D. comprehensive examination.

MINIMUM DEGREE REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE

Both the General/Experimental and the Clinical Program require a minimum of 75 credit hours. However, each program requires proficiency in several specific areas. In order to achieve such proficiency, most students must complete a total of 80 to 83 credit hours. A minimum of 20 credits must be accumulated in dissertation research and the remainder in course credits numbered in the 200 through 400 sequences of the psychology curriculum, or acceptable courses at the 200 or 300 level from other curricula. Detailed information on courses of study is available from the Department. Satisfactory performance on the department final oral examination. There is no foreign language requirement.

COURSES OFFERED

205 Learning. Analysis of theory and research on the basic learning process and behavior. *Prerequisite:* 110. Three hours. Bouton.

206 Motivation. Theory and research on the nature of motives, their influence on behavior, and their relation to other psychological processes. *Prerequisite:* 110. Three hours. Joffe.

210 Principles of Human Perception.

Focuses upon basic sensory and perceptual mechanisms that support acquisition and processing of information through auditory, visual, chemical and haptic-somatic sensory systems of animals and humans. *Prerequisite:* 109. Three hours. Staff.

220 Animal Behavior. Behavior of animals under controlled experimental conditions and in their natural environments. Consideration of antecendents of behavior and of its adaptive significance, evolution and development. *Prerequisite:* 109 or 121. Three hours. Bouton.

221 Physiological Psychology I. Structure and function of mammalian nervous system, with emphasis upon neurological correlates of sensory experience and perception. Individual laboratory experience. *Prerequisite:* 110. Four hours. Kapp.

222 Physiological Psychology II. Study of role of central nervous system mechanisms in determination of innate behavior arousal, motivation, learning, and memory. Individual laboratory experience. *Prerequisite:* 221. Four hours. Kapp.

223 Psychopharmacology. Intensive analysis of effects of drugs (medical, recreational) on behavior. Topics such as drug effects on learning, memory, motivation, perception, emotions, (normal, abnormal) aggression in animals, men. *Prerequisites:* 110, 121 or 222 or permission. Three hours. Musty.

230 Advanced Social Psychology. Advanced survey covering current research in various fields of social psychology. *Prerequisite:* 110. Three hours. Miller.

233 Psychology of Environmental Experience. Intensive examination of different ways of thinking (and feeling) about environments, including cognitive theory, research, applications to design creativity, aesthetic experience, various types of environmental awareness. *Prerequisite:* Advanced background in psychology or in environmental studies or education. Three hours. Leff.

234 Psychology of Social and Environmental Change. Psychological foundations of potential changes in social, physical environment that would enhance quality of life for all people. Emphasizes action strategies, projects, utopian visions. *Prerequisite:* Advanced background in psychology or in environmental studies or a social science. Three hours. Leff.

250 Introduction to Clinical Psychology. Basic principles of interviewing, testing, assessment, report writing. Examination of common approaches to psychotherapy: client-oriented, habit change, cognitive change, emotional change, interpersonal relations, group therapy approaches. *Prerequisite:* 110. Three hours. Kessler, Compas, Bronstein.

251 Behavior Disorders of Childhood. An overview of psychopathological development in infancy and childhood with consideration of descriptive characteristics, models or etiology, and methods of assessment and intervention. *Prerequisites:* 110. Three hours. Hasazi.

253 Advanced Behavior Modification. Application of technique for the manipulation and control of human behavior in a variety of educational and social situations involving the collection and analysis of behavioral data. *Prerequisites:* 153, 109. Lobato, Barrera.

261 Cognitive Development. Examination of research and theory concerning developmental changes in the human processing of information from infancy to adulthood centered around the work of Piaget. *Prerequisite:* 161 or 109 (concurrently), or permission of instructor. Three hours. Bond.

262 Social Development. Examination of theory and research concerning interpersonal development in humans from infancy through adulthood. Relationships between language, cognition, and social development emphasized. *Prerequisite:* 161 or 109 (concurrently), or permission of instructor. Three hours. Staff.

264 Developmental Psychobiology. Analysis of research on development of humans, animals, emphasizing effects of events in prenatal, early neonatal periods, development of physiological systems affecting behavior, evolutionary origins of behavior. *Prerequisite:* 109 or 121 or 161. Three hours. Joffe.

295, 296 Contemporary Topics. Three hours. 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.

315 Seminar in Alcohol and Behavior. A study of the influences of alcohol upon selected aspects of psychological processes including perception, attention, cognition, learning, motivation, and emotion. Three hours. Musty.

326 Central Processes: Cortical Mechanisms. Advanced studies of the prosencephalic systems in cognitive behavior, with reference to cortical function and its relationship to input and output systems. Three hours. Musty, Kapp.

331 Interpersonal Processes: Modes of Interacting. Examination of interpersonal conflict, cooperation, power relations, information transfer, and persuasion. *Prerequisite:* Permission of instructor. Three hours. Leff.

332 Interpersonal Processes: Cognition in Social Behavior. Examination of social attribution, interpersonal set, perspectives in social encounter and the formulation of interpersonal strategies. *Prerequisite:* Permission of instructor. Three hours. Leff.

340 Advanced Statistical Methods I. Study of statistical methods as aids for understanding and evaluating psychological data. Critical study of such topics as statistical estimation, analysis of variance, and correlational techniques. Three hours. Howell.

341 Advanced Statistical Methods II. Continuation of 340 with in depth study of regression and nonparametric theory and method. Further study of problems in analysis, interpretation of data from behavioral sciences. *Prerequisite:* 340. Three hours. Howell.

344 Experimental Design. Extended coverage of problems in design, analysis of behavioral experiments including repeated measures, interactions, confounding, comparisons, missing data, modeling, Latin squares, other complex designs, covariance designs, interpretations. *Prerequisite:* 340. Three hours. Howell, Gordon.

347 Measurement and Scaling. Traditional psychophysical methods, Thurstonian judgmental methods, recent topics in unidimensional scaling. Techniques, applications in multidimensional scaling. Relation of these to mental test theory, factor analysis, cluster analysis. *Prerequisites:* 340 and 341. Three hours. Gordon.

349 Special Topics in Applied Statistics. For advanced graduate students. Topics: factor analysis, discriminate function analysis, multivariate analysis of variance, advanced experimental design, introduction to Bayesian statistics, computer application in data collection, analysis. *Prerequisite:* Permission of the instructor. Three hours. Gordon and Howell.

350 Family Therapy. An exploration of current theories and techniques in family therapy, through readings and discussion, as well as observation of taped and live family therapy sessions. Graduate standing in Clinical Psychology, or permission of instructor. Three hours. Bronstein.

351, 352 Behavior Therapy. Review of literature relating to theory, practice, research. Emphasis on the evaluation as a variety of procedures applied to behavior disorders in adults and children. *Prerequisite:* Permission of the instructor. Three hours. Leitenberg.

353 Introduction to Clinical Human Neuropsychology. Clinical seminar on effects on human behavior of neocortical dysfunction. Review of theoretical, clinical approaches to brain function, emphasis on recent developments in diagnostic techniques, ensuing theoretical developments. *Prerequisite:* 221, 222 or equivalent. Three hours. Peyser.

354 Psychopathology I. An advanced course dealing with models of classification, diagnosis, epidemiology of behavior disorders in children. *Prerequisites:* Graduate standing in Psychology or permission of instructor. 3 hours. Hasazi.

355 Psychopathology II. An advanced course dealing with models of classification, diagnosis, epidemiology of behavior disorders in adults. *Prerequisites:* Graduate standing in Psychology or permission of instructor. 3 hours. Rothblum.

356 Mental Retardation. Study of abnormal behavioral development in the intellectual area. Etiology, assessment, and modification of mental retardation. *Prerequisite:* Permission of instructor. Three hours. Hasazi.

359 Interpersonal Psychotherapy. An examination of Psychotherapy as an interpersonal process. Resistance, transference and counter-transference will be examined as interpersonal interactions and related to interpersonal personality theory. *Prerequisite:* Advanced graduate standing and permission. Three hours. Kessler.

360 Methods and Models of Clinical Prediction. Study of clinical versus actuarial problems in applied psychology. Historical antecedents, examples of problems of reliability, validity, utility models of intelligence and personality. Modern day solutions. *Prerequisite:* 340 or permission of instructor. Three hours. Kessler.

361 Advanced Personality Theory. Survey of present-day personality theories according to issues involved, explanatory demands made on a theory. Emphasis on usefulness to psychotherapy, organism-operational-Adlerian type theory favored. *Prerequisite:* Permission of instructor. Three hours. Bronstein.

362 Community Clinical Psychology. Seminar in current philosophy, approach to mental health problems. Topics: history, development of community mental health and community clinical psychology, consultation methodology, research problems. *Prerequisite:* Permission of instructor. Three hours. Staff.

363 Primary Prevention. Review of research literature on prevention of psychopathology and promotion of competence; development of model prevention programs; evaluation, ethical issues, and political issues. *Prerequisites:* Graduate standing, permission of instructor. Three hours. Albee.

364 Professional Affairs and Ethics. The origins of professions and of psychology in particular. Accreditation, laws affecting psychology, organization of the profession, licensing certification, and the code of ethics for psychology. *Prerequisites:* Graduate standing, permission of instructor. Three hours. Albee.

365 Group Therapy. A comprehensive review of encounter, training, and psychotherapy group issues. Discussions focus on group composition, leadership styles, group stages, group problems, ethical issues, and research questions. *Prerequisites:* Graduate standing or permission of instructor. Three hours. Deitzel, Bronstein.

366 Seminar in Advanced Developmental Psychology. Critical analysis of new topics of current significance in Developmental Psychology. Research, theory, applied, professional issues including, for example, moral development, infancy, early conceptual development, professional writing. *Prerequisites:* Graduate standing or permission. Three hours. Staff.

367 Human Sexual Behavior. An exploration of various topics in human sexuality including sexual behavior through the life span, sexual preference, and treatment of sexual dysfunction and deviation. Graduate standing in Psychology or permission of instructor. Three hours. Leitenberg.

368 Psychology and Law. A study of mental health law (including the insanity defense, and commitment) and of legal processes (jury decision-making, jury selection, eye witness testimony). *Prerequisites:* Graduate standing. Three hours. Kessler.

369 Health Psychology. Psychological aspects of the etiology, treatment, prevention of physical illness. Topics include: stress and disease, compliance health care systems, coping with illness, positive health behavior. *Prerequisite:* Permission of instructor. Three hours. Rosen.

370, 371 Introductory Practicum: Assessment and Therapy I & II. Role of psychologist as consultant, emphasis on evaluation of mental abilities, behavioral, personality adjustment. Therapy practicum covers basic psychotherapy, case management, utilization of supervision. *Prerequisites:* Graduate standing and permission of instructor. Three hours. Compas, Rosen.

372 Advanced Clinical Practicum. Supervised experience in a variety of clinical settings including the Medical Center Hospital; the State Hospital; Community Mental Health Facilities; Behavior Therapy Center; Counseling Center. *Prerequisites:* Graduate standing in psychology and permission of instructor. Three hours. Leitenberg, Staff.

380 Contemporary Topics. Selected topics in depth, emphasis on critical analysis of original literature. Recent topics: anxiety, behavioral pharmacology, biological bases of memory, depression,

psycholinguistics, psychotherapy research, primate behavior, skilled performance. Three hours.

385 Advanced Readings and Research. Readings, with conferences, to provide graduate students with backgrounds and specialized knowledge relating to an area in which an appropriate course is not offered. One to three hours.

391 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

Not offered 1982-83, but regular courses:

207 Thinking

261 Cognitive Development

262 Social Development

357 Research in Schizophrenia

358 Antisocial Behavior

The following courses are offered infrequently but may be taught where sufficient student interest is demonstrated.

305 Seminar in Learning Theory. Three hours.

308 Seminar in Operant Conditioning. Three hours.

310 Seminar in Perception. Three hours.

333 Interpersonal Processes: Motivation in Human Interaction. Three hours.

RELIGION (See Page 177)

SOCIOLOGY (See Page 177)

SPANISH (See Page 180)

STATISTICS

Steering Committee Members: Professors McCrorey and Sylwester (Director); Associate Professors Ashikaga, Gordon, Haugh, Howell, Newton, and Tashman; Assistant Professor Costanza; Associate Research Professor Aleong; Assistant Research Professor McAuliffe; Adjunct Assistant Professor Whitmore.

The Statistics Program offers statistics and probability courses for the entire University community along with traditional degree programs and individually designed degree programs emphasizing statistics applied to other fields. The degree programs are designed primarily for students who plan careers in business, industry, and government or advanced training in disciplines that make extensive use of statistical principles and methods. The Program faculty is deeply involved in consulting and collaborative research in a wide variety of fields, especially in agriculture and in the basic and clinical medical sciences. These research activities along with the research of participating faculty from psychology, natural resources, business administration, etc., offer students unique opportunities to apply their classroom training to "real world" problems. Qualified students with the goal of learning statistics to use in a specialized area of application are especially encouraged to take advantage of these cooperative arrangements.

Program faculty have active statistics research efforts in areas such as time series analysis, survival data analysis, discriminant analysis, regression diagnostics, and experimental design. Students seeking the traditional graduate degree in statistics (along with course work in mathematics and computer science, if desired) have excellent opportunities to participate in the faculty research.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES AND ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

A baccalaureate degree. Three semesters of calculus, a course in matrix methods, and one semester of statistics. Provisional acceptance can be given prior to the completion of these requirements. Satisfactory scores on the general (aptitude) portion of the Graduate Record Examination are required for some sources of financial aid. Computer experience is highly recommended.

MINIMUM DEGREE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

Plan A: (Thesis) Twenty-four semester hours of approved graduate credits in statistics, mathematics, and other quantitative methods and (if appropriate) a specialized field of application, and six semester hours of thesis research.

Plan B: (Non-Thesis) Thirty semester hours of approved credits in statistics, mathematics and other quantitative methods and (if appropriate) a specialized field of application, with no thesis required.

Under both plans students must acquire a graduate level knowledge of 201, Statistical Methods I-IV, at least six semester hours of probability and statistical theory, and 383, 384. Additional specific courses may be required depending on the student's background and interest. Other courses are selected with the approval of the student's advisor from statistics, mathematics, computer science, and (if appropriate) graduate level courses from the student's intended area of specialty application (e.g. business administration, engineering, ecology, genetics, psychology). The student is expected to participate in the Colloquium series of the Program. Plan A and Plan B require successful completion of a comprehensive examination which includes coverage of theoretical and applied aspects of advanced statistics courses taken by the student. A specialized application may be included as part of the comprehensive exam if appropriate. Under Plan B a student, in lieu of a thesis, must carry out an approved comprehensive data analysis culminating in both an oral and written report to the faculty.

COURSES OFFERED

201 Statistical Analysis Via Computer. Intensive coverage of computer-based data preprocessing and analysis using statistical packages, subroutine libraries, user-supplied programs. Students analyze real data, prepare comprehensive report. *Prerequisites:* Statistics 111 with permission of Director, or 141, or corequisite Statistics 211 or 308. Three hours.

211 Statistical Methods I. Fundamental ideas, techniques, applications of statistics used in experimental design, data analysis. Includes: descriptive and inferential statistics, correlation, regression, analysis of variance. *Prerequisite:* Junior standing, college algebra. Three hours.

221 Statistical Methods II. Continuation of 211. Includes: multiple regression, experimental design, analysis of variance and covariance, non-parametric methods. Realistic data used in projects, calculations performed on UVM computer. *Prerequisite:* 141 with instructor permission or any one of 211, 241, or 262; Junior standing. Three hours. Aleong.

223 Statistical Methods III. Analysis methods for categorical and continuous multivariate data; measures of association, combining two-by-two tables, loglinear models, continuous multivariate procedures (discriminant analysis, principal components, factor analysis). *Prerequisites:* 141 plus a second Statistics course, 211 or 308. Three hours.

224 Statistical Methods IV. Methods and techniques for survey sampling (including stratification and clustering methods), industrial quality control (acceptance sampling and control charts for process control), and reliability and survival analysis. *Prerequisites:* 141 plus a second Statistics course, 211 or 308. Three hours.

225 Applied Regression Analysis. Nature and applications of basic regression-correlation models in investigating relationships, testing hypotheses, making predictions. Emphasis: developing appropriate models, evaluating existing research. Same as BSAD 270. *Prerequisite:* Any one of 111, 141, 211, 241, 261, or 308. Three hours.

227 Statistical Methods for the Behavioral Sciences. See Psychology 341.

229 Statistical Methods for the Engineering Sciences. Multiple regression and response surface modeling, factorial design of experiments, statistical quality control. Probability distributions used in reliability and life testing. *Prerequisite:* Any one of 141, 211, 241, 262, or 308. Three hours.

231 Experimental Design. Basic experimental designs, complete and incomplete blocking, factorial designs; response surface methods, fixed and random effects models. *Prerequisite:* Any one of 141, 211, 241, 262, or 308. Three hours. Aleong.

241 Introduction to Statistical Inference. Introduction to statistical theory: parameter estimation, hypothesis testing, chi-square tests, regression analysis, and analysis of variance. *Prerequisites:* Math 121. Stat 151 or 251 and a course in statistical methods are recommended. Three hours.

251 Probability Theory. Non-measure theoretic course in probability, meeting for first 11 weeks of fall semester. Derivation of classical distributions, laws of large numbers and central limit theorems. *Prerequisite:* Math 121. STAT 151 recommended. Three hours.

252a, b, c Stochastic Processes and Time Series. Three one-credit mini-courses: 252a, Discrete processes: Random walks, Markov chains and discrete branching processes. *Prerequisite:* 151 or 251. 252b, Continuous processes: Poisson, birth and death, and queueing processes. *Prerequisite:* 151 or 251. 252c, Time Series Analysis: Autoregressive-moving average models, auto and partial correlation functions, computer modeling. *Prerequisite:* Any one of 141, 211, 225, 241, or 262.

261, 262 Statistical Theory I,II. Methods of point and interval estimation, hypothesis testing, and decision theory. Application of general principles to specific areas such as non-parametric tests, sequential analysis and linear models. *Prerequisites:* For 261: 151 with instructor permission or 251. For 262: 241 with instructor permission or 261. Credits: 261: one hour, meeting last 4 weeks of Fall semester. 262: four hours.

281 Statistics Practicum. Intensive experience in carrying out a complete statistical analysis for a research project in a substantive area with close consultation with the project investigator. 1-4 credit hours. *Prerequisites:* One year of statistics and elementary computer programming.

295 Special Topics. For advanced students. Lectures, reports and directed readings on advanced topics. *Prerequisite:* As listed in course schedule. 1-4 credit hours as arranged.

308 Biometrics and Applied Statistics. See Physiology 308.

313 Statistical Analysis for Management. See BSAD 313. *Prerequisites:* Previous employment or educational experience in data analysis is recommended. Three credits. No credit for graduate students in statistics or biostatistics. Tashman.

383, 384 Seminar I, II. Topics of current faculty, graduate and advanced undergraduate student interest presented in seminar-discussion format. Special attention to topics being covered in Statistical Methods III, IV. 1 hour each. *Prerequisites:* 241 or 262. *Co-requisites:* 223 for 383, 224 for 384.

385 Consulting Practicum. Supervised experience, directed reading and discussions in statistical consulting. Enrolled students will advise faculty and students from other Departments with statistical problems related to their research projects. *Prerequisites:* Second year graduate standing in Statistics or Biostatistics and permission of Statistics Program Director. One to three hours each semester. Chalmer.

391 Master's Thesis Research. Credit as arranged.

TEXTILES, MERCHANDISING, AND CONSUMER STUDIES (See Page 180)

VOCATIONAL EDUCATION AND TECHNOLOGY

Professor Fuller (Chairperson); Associate Professors Albright, Bloom, Ferreira, Kelly and Shimel; Assistant Professors Hasazi and Snook; Extension Associate Professors Harris, Moore, Patterson and Wells; Lecturer Zimmerman.

The department offers two areas of concentration:

(a) Occupational and Practical Arts Education — which leads to either an M.A.T. or an M.Ed. degree, and

(b) Extension Education — which leads to a Master of Extension Education degree

Individuals seeking a maximum amount of flexibility in a program based upon both undergraduate and graduate courses are encouraged to consider the Fifth Year Certificate in Education (see page 33 of this catalogue).

OCCUPATIONAL AND PRACTICAL ARTS EDUCATION

The Master of Arts in Teaching Degree Program

The goal of this program is to strengthen an individual's background in a teaching field. The specialized areas of interest include agriculture and natural resource education, home economics education, industrial arts, industrial education, and vocational-special needs education.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS IN TEACHING

An undergraduate degree in an appropriate field of specialization. Acceptable scores on the general (aptitude) portion of the Graduate Record Examination.

MINIMUM DEGREE REQUIREMENTS

See page 49 for regulations of the Graduate College.

Completion of the necessary courses to meet the minimum requirements for a teaching certificate. Candidates who do not qualify for a teaching certificate, but have satisfactory teaching field preparation and Graduate Record Examination scores will need to complete a professional field experience in addition to the minimum degree requirements. The Department expects a candidate to complete

at least 18 semester hours in professional education in his or her combined undergraduate and graduate programs, which includes preparation in the areas of Foundations of Education, methods for teaching, and learning and human development. Usually not more than six hours of independent study are allowed. A candidate is expected to complete at least one semester or two summers in residence on the University of Vermont campus in Burlington. Inquiries should be directed to Professor Gerald R. Fuller.

The Master of Education Degree Program

The goal of this program is to prepare the individual for professional leadership in occupational and practical arts education. Programs are planned jointly with the College of Education and Social Services in guidance and counseling, occupational education for the mentally retarded, or to meet individual goals as they relate to occupational and practical arts education.

The Department expects each candidate to include study in one or more of the following areas as they relate to occupational and practical arts education: improvement of instruction, principles and problems involved in curriculum development, planning and managing educational programs, and/or research.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF EDUCATION

An undergraduate degree in an appropriate area. Acceptable scores on the general (aptitude) portion of the Graduate Record Examination.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF EDUCATION

Eighteen hours of education courses or appropriate certification.

MINIMUM DEGREE REQUIREMENTS

See page 48 for regulations of the Graduate College.

A candidate is expected to complete at least one semester or two summer sessions in residence on the University of Vermont campus in Burlington. Additional information on this degree program may be found on page 48 of this catalogue. Inquiries should be directed to Professor Gerald R. Fuller, College of Agriculture.

EXTENSION EDUCATION

The goal of this program is to improve the knowledge and competencies of the student in a career field coupled with preparation for educational leadership functions. Programs of study may be designed for educational responsibilities in one of the following specializations in the non-school based setting: agricultural or related agencies and organizations, business and industry, and youth programs and organizations.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF EXTENSION EDUCATION

An undergraduate degree with an acceptable major area of specialization. An acceptable score on the Graduate Record Examination general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS

See page 51 for regulations of the Graduate College. A candidate is expected to complete at least six semester hours in the Vocational Education and Technology Department. Usually courses in political science, sociology, and/or research will be taken. Not more than six hours of independent study are allowed in a candidate's program. One year of satisfactory professional experience. Students who do not have the professional experience must complete a field experience in addition to the minimum degree requirements. A candidate is expected to complete at least one semester or two summers in residence on the University of Vermont campus, Burlington, Vermont. Inquiries should be directed to Professor Gerald R. Fuller.

COURSES OFFERED

270 Educating Students with Special Needs in Vocational Education. (3-0) Legal, social & economic forces affecting vocational programming for special needs students (handicapped & disadvantaged). Programs, resources & procedures for educating special learners in vocational education. *Prerequisite:* Admission to an approved teacher certification program or permission of instructor. Three hours. Albright.

271 Workshop in Teaching Students with Special Needs in Vocational Settings. Intensive preparation in selecting contemporary instructional strategies & materials and in adapting and using equipment in regular and special vocational education programs. *Prerequisite:* Completion of 12 credits in Vocational or Special Education at the 100 or 200 level or permission. Offered during summer sessions. Variable credit; one to three hours; may enroll more than once for total of six credits. Albright.

275 Developing Vocational Instruction for Students with Special Needs. (3-0) Focus on development of instructional strategies for including handicapped students in vocational education. Procedures for developing, implementing and evaluating individualized vocational plans. *Prerequisite:* Admission to an approved teacher certification program or permission of instructor. Three hours. Albright, Hasazi.

283 Teaching Adults. Problems related to organizing and planning adult education programs for schools, community organizations, government agencies or business. Techniques for teaching adults will be analyzed. *Prerequisites:* Senior standing, 82 or 52 and 182, or permission of instructor. Three hours. Kelly, Patterson.

292 Seminar. Reports, discussions and investigations in selected fields. Students may enroll more than once for total of six hours. *Prerequisites:* Six hours 100 level and permission of instructor. One to three hours. I, II.

295 Special Topics. Lectures, laboratories and/or readings and reports, relating to contemporary areas of study. A student may enroll more than one time and accumulate up to nine hours. *Prerequisite:* Six hours 100 level and Departmental permission. Credit as arranged. I, II. Staff

377 Practicum in Vocational and Extension Education. Advanced supervised practicum to provide direct involvement in vocational or extension education settings. Individually planned to apply course related learning in an applied setting. *Prerequisites:* Completion of at least 6 hours in appropriate 200 level VOTC courses or permission of instructor. Variable credit; one of three hours. Summer I, II.

ADDITIONAL GRADUATE COURSE

The following course is offered by the Vocational Education and Technology Department upon request, usually in the Summer Session and in the Evening Division.

251 Methods for Teaching Occupationally Oriented Subjects. Three hours.

WILDLIFE AND FISHERIES BIOLOGY

For description of the M.S. Program in Wildlife and Fisheries Biology see NATURAL RESOURCES, page 144.

ZOOLOGY

Professors Bell, Glade, Happ (Chairperson), Heinrich, Henson, and Potash; Associate Professors Davison, Kilpatrick, Landesman and Stevens; Assistant Professors Herbers, Pennypacker, Schall, VanHouten, and Wilson.

Faculty research interests fall into two broad groupings, Developmental Biology/Cellular Biology/Physiology and Ecology/Evolution/Natural History. Current ongoing research projects include: taxonomy and natural history of insects, particularly Rhysodid beetles; aquatic ecology, wetlands ecology, limnology, running water systems; parasite-host ecology, population and community ecology of lizards; evolution of insect societies, behavioral ecology; population genetics and molecular systematics; regulation of reproduction in freshwater invertebrates; physiological energetics of insects; establishment of amphibian axiation and limb regeneration; mechanisms of growth control in amphibians; cell and matrix interactions in development; developmental genetics of juvenile hormone and oogenesis in *Drosophila;* cell biology of insect development; insect reproductive biology; genetics of chemoreception and chemotactic behavior of protozoa; electrophysiological basis of swimming behavior; cellular basis of immunological response.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE

An undergraduate major in zoology or its equivalent. Satisfactory scores on the Graduate Record Examination, general (aptitude) section. Acceptability to the faculty member with whom the candidate wishes to do thesis research.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF MASTER OF SCIENCE

Satisfactory completion of a qualifying examination.

MINIMUM DEGREE REQUIREMENTS

Zoology Graduate Colloquia, four hours; 11-18 additional hours in zoology and related fields; thesis research (eight to 15 hours). Each candidate must participate in the teaching of at least one undergraduate course.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF ARTS IN TEACHING

The department offers a program leading to the degree of Master of Arts in Teaching: See p. 49. Satisfactory scores on the Graduate Record Examination, general (aptitude) section, are requirements for acceptance for this degree.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF MASTER OF SCIENCE FOR TEACHERS (BIOLOGY)

A bachelor's degree from an accredited institution and certification as a teacher of biology or an associated field. At least three years of secondary school teaching. Satisfactory scores on the Graduate Record Examinations, general (aptitude) section.

MINIMUM DEGREE REQUIREMENTS FOR THE M.S.T. (BIOLOGY)

Thirty hours of course work to include a selection of courses in the Departments of Botany and Zoology which will broaden and balance the undergraduate work in biology. At least two 200 level courses in each department. Courses in four of the five following areas: anatomy, morphology and systematics; genetics; developmental biology; and environmental biology. Up to 12 hours of 100 level courses may be used for the above requirements where approved by the advisor and the Dean. Appropriate courses in related science departments may be used to complete the required 30 hours. No thesis is required; however, each degree recipient must complete a written and oral examination.

REQUIREMENTS FOR ADMISSION TO GRADUATE STUDIES FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Satisfactory completion of: 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; the Graduate Record Examination, general (aptitude) section; and acceptability to the faculty member with whom the candidate wishes to do dissertation research.

REQUIREMENTS FOR ADVANCEMENT TO CANDIDACY FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The qualifying examination; demonstrated competency in two of four areas as determined by the studies committee: (1) statistical applications, (2) computer applications, (3) a reading knowledge of an appropriate foreign language, and (4) a reading knowledge of a second appropriate foreign languge; at least one but not more than two academic years of graduate study at the University of Vermont. Students whose programs are to include physical chemistry should have had, or should take, mathematics through Mathematics 121 or its equivalent.

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 and must include six hours of Graduate Colloquia. The selection of courses will be designated for each student by his/her

Studies Committee. Of these courses, a minimum of 13 credits must be in courses other than zoology. At least 20, but not more than 35, credits must be earned in dissertation research. Each candidate must participate in the teaching of at least one undergraduate course.

COURSES OFFERED

202 Quantitative Biology. Mathematical concepts applied to biological problems such as growth, metabolism, temperature effects, kinetics, and graphic interpretation of data. Statistics will not be treated. *Prerequisite:* An intermediate level course in biology, Mathematics 9, or permission of instructor. Three hours. Davison.

203 Population Ecology. (Biology 203) Analysis of growth, regulation, and interrelations of biological populations in theoretical, laboratory, and natural systems. *Prerequisite:* Biology 102. Three hours. Schall. Alternate years, 1983-84.

205 Advanced Genetics Laboratory. Illustration of important genetic concepts. *Prerequisite:* Biology 101. Two hours. VanHouten.

208 General Entomology. Morphology, physiology, and evolution of insects. *Prerequisite:* 104 or Biology 102. Four hours. Bell. Alternate years, 1984-85.

209 Field Zoology. Collection and identification; study of local habitats, their nature, and adaptations to them; factors governing distribution; methods of preparing study specimens. *Prerequisite:* 104 or Biology 102. Four hours. Bell.

211 Embryology. Principles exemplified by typical invertebrate and vertebrate embryos. *Prerequisite:* 104. Four hours. Glade.

212 Comparative Histology. Anatomy of tissues, chiefly vertebrate. Tissue similarities and specializations of organs among the various groups of animals in relation to function. *Prerequisite:* 104. Four hours.

216 Human Genetics. Inheritance; population genetics; interaction of heredity and environment; application to human problems. *Prerequisite:* Biology 101. Three hours. Not offered 1983-84.

217 Mammalogy. Classification, identification, morphology, evolution, behavior, and distribution. *Prerequisite:* Biology 102. Four hours. Kilpatrick.

219 Comparative and Functional Vertebrate Anatomy. Structure, function, and phylogeny; evolutionary and functional trends; investigation of the structure of all chordate groups. *Prerequisite:* 104. Four hours. Kilpatrick. Alternate years, 1983-84.

222 Experimental Embryology. Theoretical approach based on research in embryology, genetics, physiology, bacteriology, and related fields. *Prerequisites:* 211 and permission of instructor. Four hours. Glade. Not offered 1983-84.

225 Environmental Physiology. Processes by which animals cope with moderate, changing, and extreme environments. *Prerequisites:* Biology 102 and 104. Three hours. Heinrich.

231 Cell Physiology. Experimental techniques used to elucidate chemical and physical mechanisms within living cells. *Prerequisites:* Biology 103; Chemistry 141, 142 and permission of instructor. Four hours. Pennypacker. Alternate years, 1984-85.

236 Limnology. The ecology of standing waters; the biota of lakes as related to the geological, physical, and chemical conditions of lakes. *Prerequisite:* Biology 102, chemistry. Four hours. Henson.

237 Ecology of Running Waters. Stream and river environments, adaptations of organisms to varying physical, chemical, and biotic conditions. *Prerequisites:* Biology 102, chemistry. Four hours. Potash.

240 Invertebrate Ecology of the Mountains. An intensive study of the invertebrate fauna of Camel's Hump and vicinity. *Prerequisite:* Biology 102 or a course in invertebrate or insect taxonomy. Four hours. Bell. Offered summer 1983.

250 Invertebrate Zoology. Anatomy, physiology, and life histories of representatives of the more important phyla. Four hours. Henson.

251 Insect Structure and Function. Anatomy and physiology with emphasis

upon growth, reproduction, and sensory physiology. *Prerequisite:* 104 or permission of the instructor. Four hours. Happ. Alternate years, 1983-84.

255 Comparative Animal Physiology. General principles of function in invertebrates and vertebrates. *Prerequisites:* 104; Chemistry 141, 142; and permission of instructor. Four hours. Davison.

262 Biological Basis of Behavior. The structure and function of neural and hormonal mechanisms involved in animal behavior with emphasis on phylogeny. *Prerequisite:* Biology 103 or permission of instructor. Three hours. Stevens.

263 Genetics of Cell Cycle Regulation. Molecular events during the cell cycle; mutants defective in cell cycling; comparison of normal and transformed (cancer) cell cycling. *Prerequisite:* Biology 101 or permission of instructor. Three hours. VanHouten.

270 Modern Evolutionary Theory. Contributions of modern research in genetics, systematics, distribution, experimental embryology, serology, and related fields to problems of evolutionary change. *Prerequisite:* Biology 101 (102 recommended). Three hours. Kilpatrick. Alternate years, 1984-85.

271 Advanced Limnology. Analysis of current concepts and problems. *Prerequisite:* 236. Three hours. Henson. Alternate years, 1983-84.

281 Seminar. Review and discussion of current zoological research. Attendance required of Zoology graduate students. Seniors in zoological research programs are expected to enroll. Without credit.

295 Special Topics.

371 Graduate Colloquia. Topics of current faculty and graduate student interest presented in a seminar-discussion format. Specific titles for colloquia will be listed in the course schedule. One hour.

381 Special Topics. Readings with conferences, small seminar groups, or laboratories 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 Master's Thesis Research. Credit as arranged.

491 Doctoral Dissertation Research. Credit as arranged.

Courses of Instruction for Graduate Credit

The following courses are offered for graduate credit by departments and programs that do not offer a graduate degree program. Some of the courses below may be appropriate to satisfy a portion of the course requirements for a specific graduate degree program listed earlier.

ANTHROPOLOGY

200 Field Work in Archaeology. Methods and techniques of archaeological investigation in field situations and laboratory analysis of data. *Prerequisites:* 24, one 100 level course in anthropology. Six hours. Summers only. Petersen.

210 Archaeological Theory. Development of archaeology from the 19th century to the present. *Prerequisites:* 24, one 100 level anthropology course; or HP 201; or graduate standing in Historic Preservation Program, or History 105, 106, or 107. Three hours. Power. Alternate years.

225 Anthropological Theory. Schools of Anthropological thought in relation to data on non-western societies and the historical and social context in which the anthropologist works. *Prerequisites:* 21 and one 100 level course. Three hours. C. Pastner.

228 Social Organization. Examination of the basic anthropological concepts and theories used in the cross-cultural analysis of kinship and marriage. *Prerequisites:* 21 and one 100 level course. Three hours. Mitchell.

283 Culture Change. Study of sociocultural transformations in non-western countries. *Prerequisites:* 21, one 100 level course, or 21, six hours in the social sciences. Three hours. Alternate years. Gordon.

290 Methods of Ethnographic Field Work. Examination of theoretical and ethical premises of field work methodology. *Prerequisite:* Twelve hours of anthropology. Three hours. Mitchell. Alternate years.

295, 296 Advanced Special Topics. *Prerequisites:* 21 and one 100 level course.

ART

201 Architecture and the Environment. See Historic Preservation 201. Three hours. Liebs.

207 Studies in American Art or Architecture. Selected topics in American art and/or architecture, individual research and reports. Three hours. Janson or Lipke.

282 Directed Studies. Individual or group study in a special area. *Prerequisites:* Six hours advanced, three in the chosen area and permission. Three hours.

EXTRA-DEPARTMENTAL COURSES

Area Studies 297, 298. Seminar for area studies majors and other qualified students conducted by a team of area specialists and covering selected topics through interdisciplinary and comparative approaches. *Prerequisites:* Permission by the executive committee of Area Studies. Three hours. Staff.

Environmental Studies 295. Advanced Seminar. Credit as arranged. Staff.

Environmental Studies 291. Special Topics. Credit as arranged. Staff.

General Literature 251, 252 Study of Movement, Genre, or Topic. Precise content of the course to be announced before the registration period, chosen from the following (or similar) topics: 1. *Medieval Epic* (French, Germanic, Spanish); 2. *Comedy* (Classics, English, French); 3. *Enlightenment* (French, English, German); 4. *European Romanticism* (English, French, German); 5. *Political Literature in the Nineteenth Century* (English, French, German); 6. *Existentialism in Literature*

(French, German, Spanish); 7. *Avant-Garde Theater* (French, German, American); 8. *Tragedy* (Classics, French, German). *Prerequisite:* Any 100-level literature course in any of the cooperating departments. Three hours. Staff.

Graduate College 301 Seminar in College Teaching. Practical assistance to the beginning teacher in developing an effective, individual teaching style. Activities include analysis of approaches to teaching; discussion with faculty from various departments; micro-teaching exercises. *Prerequisites:* Graduate Teaching Fellowship and selection by department. Three hours. Holmes.

Graduate College 395 Special Topics. Workshop in the Social Sciences. Staff.

Technology 201 System Dynamics Seminar. Review of system-dynamics literature. Detailed study of conceptualization, paradigms, generic structures, validation and implementation. Term project and paper in field of interest of students are required. *Prerequisite:* TECH 101 Principles of System Dynamics. Three hours. Roth.

MUSIC

203, 204 Orchestration. Instrumental characteristics, arranging for orchestra; second semester: advanced orchestral scoring. *Prerequisites:* 116, 203 for 204. Three hours.

205, 206 Counterpoint. First semester: Tonal counterpoint; second semester: canon and fugue. *Prerequisite:* 116. Three hours.

208, 209 Form and Analysis. Creative approach to aural and sight analysis of musical construction. *Prerequisites:* 116; 205 recommended. Three hours.

211, 212 Conducting. Baton technique, score reading, laboratory practice; second semester: preparation and performance of selected scores, including score reading at the piano and rehearsal procedures. *Prerequisites:* 16; 211 for 212. Three hours.

215, 216 Composition. Creative work in free composition according to the needs and capabilities of the individual student. *Prerequisites:* 205 and 208 or permission of instructor. May be repeated for credit. Three hours.

245, 246 Chamber Music Literature. Study through analysis and performance of masterworks for small groups leading to public performance. *Prerequisites:* Twelve hours or the equivalent in performance field and permission of instructor. May be repeated for credit. One hour.

281 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.

OBSTETRICS AND GYNECOLOGY

295 Special Topics. Lectures, readings, or laboratory investigations for advanced students within areas of expertise of faculty and staff. *Prerequisite:* permission of instructor. Credit as arranged.

(Human Reproduction: Concepts in areas of human reproduction, including critical evaluation of current technology, controversy in human reproduction. Anatomy, physiology, endocrinology and pathophysiology of human reproduction. *Prerequisite:* permission of instructor. Spring: Non-pregnancy aspects. Four hours. Fall: Pregnancy aspects. Four hours. Auletta.)

ORTHOPAEDIC SURGERY

291, 292 Research in Orthopaedics and Rehabilitation. Work on research problem under the direction of a faculty member. Review of literature, preparation of manuscript. *Prerequisite:* Departmental permission. 3 credit hours. Pope, Stokes. (In collaboration with clinical faculty of the department.)

PHILOSOPHY

201 Theory of Knowledge. A critical examination of the nature and sources of knowledge: belief, truth, evidence, perception, memory, and induction. *Prerequisite:* 102 or 112. Three hours. Kornblith, Sher.

202 Metaphysics. A critical examination of such topics as the nature of space and time, the concept of change, the identity of the self, the nature of the world and our place in it. *Prerequisite:* 101 or 102 or 110. Three hours. Mann, Moneta, Sher.

210 Philosophy of Mind. Major philosophical theories of the mind and its relation to the physical world, the nature of sensation, desire, and belief, and the relation between thought and action. *Prerequisite:* 102 or 110. Three hours. Kornblith, Sher.

212 Philosophy of Science. A thorough investigation of one or two problems in the philosophy of science. Emphasis on modern attempts to solve them. *Prerequisite:* 112 or any 100 level history of science course or Junior or Senior standing in a science major. Three hours.

213 Mathematical Logic. A study of important advanced results in mathematical logic, including Godel's Incompleteness Theorems and an introduction to proof theory and recursive function theory. *Prerequisite:* 113. Three hours.

215 Philosophy of Mathematics. Philosophical topics connected with mathematics. What (if anything) is mathematics about? How do we acquire our mathematical knowledge? *Prerequisite:* 113 or 213 or extensive background in mathematics. Three hours.

217 Philosophy of Language. A philosophical study of the nature of language. *Prerequisite:* 113 or linguistics 100, 102. Three hours. Hansen, Kornblith, Sher.

221 Topics in Chinese Philosophy. A detailed examination of a classical chinese philosophical text or school. *Prerequisite:* 121 or 122. Three hours. Hansen.

240 Contemporary Ethical Theory. An analysis of the ideas of contemporary moral philosophers in normative ethics and metaethics. *Prerequisites:* 140, 142, or 144. Three hours. Kuflik, Sher.

241 Contemporary Social and Political Philosophy. An analysis of the ideas of contemporary philosophers in social and political philosophy. *Prerequisites:* PHIL 140, 142, 143, or 144. 3 hours. Kuflik, Sher.

242 Justice and Equality. An examination of contemporary normative theories of distributive justice and equality. *Prerequisites:* PHIL 140, 142, 143, or 144. Cross-listings: Same course as Political Science 213. 3 credit hours. Kuflik, Sher; Wertheimer (Political Science).

260 Phenomenology II. A critical and intensive investigation of the thought of a major twentieth century phenomenologist, e.g. Husserl, Heidegger, Merleau-Ponty, or Gadamer. *Prerequisite:* 160. Three hours. Moneta.

262 Existentialism. A study of existentialism as a philosophy, and an examination of its background, as displayed in the literary and philosophical writings of Pascal, Kierkegaard, Camus, Heidegger, and Sarte. *Prerequisites:* Any two of 101, 102, 107. Three hours. Hall.

265 American Philosophy. The thought of such leading American philosophers as Peirce, James, Royce, Santayana, Dewey and Whitehead. *Prerequisites:* 101, 102. Three hours. Miller.

271, 272 Seminar: Major Philosophical Author or School. A study of the major philosophical texts by a single author or school of thought. May be repeated for credit when different authors are studied. *Prerequisite:* An appropriate 100-level course in philosophy. Three hours.

281, 282 Seminar: Selected Topics in Philosophy. *Prerequisite:* An appropriate 200-level course in philosophy. Three hours. Staff.

297, 298 Readings and Research. Independent study with an instructor on a specific philosopher or philosophical problem. *Prerequisite:* An appropriate 200-level course in philosophy.

RELIGION

291, 292 Topics in the History and Phenomenology of Religion. *Prerequisites:* Nine hours in religion; junior standing. Three hours. Staff.

SOCIOLOGY

Courses numbered 200 to 299 require a minimum of **six hours of sociology,** three of which must be at the 100 or intermediate level, equivalent preparation as indicated or permission of the instructor.

202 Population Dynamics. Analysis of factors affecting human population growth,

distribution, migration patterns, relationship between economic activity and population trends. *Prerequisites:* Six hours of sociology or Soc. 10 and an introductory course in biology, economics, geography or zoology. Three hours. McCann, Stedman.

204 Ecological Perspective on Human Communities. Analysis of relationships between social, economic, technological organization of communities and their physical and sociocultural environments. Emphasis upon community land use, settlement patterns. *Prerequisites:* Six hours of sociology or Anthropology/Georgraphy 179. Three hours. Mabry, Schmidt, Stedman.

205 Rural Communities in Modern Society. Changing structure, dynamics of urban social organization in context of modernization and urbanization. Emphasis on rural communities in United States. Three hours. Finney, Schmidt.

206 Urban Communities in Modern Society. Changing structure, dynamics of urban social organization in context of modernization and urbanization. Emphasis on cities, metropolitan areas in United States. Three hours. Lewis, Loewen, Stedman.

207 Community Organization and Development. Communities as changing sociocultural organizational complexes within modern society. Problems of formulation, implementation of alternative change strategies. Three hours. Finney and Schmidt.

209 Small Groups. Structure and dynamics of small groups and the interpersonal, informal network of relations that characterize interaction of members. Three hours. Nixon, Steffenhagen.

211 Social Movements and Collective Behavior. Examination of origins, development, structure, consequences of crowds, riots, crazes, rumors, panics. Political, religious movements and their relationships to cultural, social change. Three hours. Danigelis, Finney, Folta, Sampson, Schmidt, Stanfield.

214 Delinquency. Analysis of nature, types of juvenile behavior that violates law. Mechanisms for defining such behavior as delinquent, their causes and consequences. Three hours. Folta, McCann.

216 Criminal Justice. Analysis of social structures, processes involved in identification, labeling of individuals as criminal offenders: criminal law, its enforcement and the courts. Three hours. Folta, Stanfield.

217 Corrections. Analysis of social structures, processes involved with individuals designated as offenders of criminal law; probation, prison, parole, programs of prevention, rehabilitation. Three hours. Stanfield, Fishman.

219 Race Relations. Examination of American racial subordination in social, historical perspective. Analysis of interracial contacts, racial subcultures, social structures. Responses to racial prejudice, discrimination. Three hours. Danigelis, Loewen.

225 Organizations in Modern Society. Examination of basic classical and contemporary theory, research on human relations, internal structures, environments, types, general properties of complex organizations, bureaucracies. Three hours. Berkowitz, Finney, Folta, Sampson.

228 Organizational Development and Change. Examination of basic, applied research on problems of organizational effectiveness, innovation. Presentation of organizational development, change techniques, practical class exercises. *Prerequisites:* Six hours of sociology, or one college course on organizations, or equivalent organizational experience with permission of instructor. Three hours. Berkowitz, Finney.

229 The Family as a Social Institution. The institution of the American family in cross-cultural, historical perspective. Theories, research on family continuity, change, institutional relationships. *Prerequisites:* Soc. 129 or six hours of sociology. Three hours. Berkowitz, Fengler, Folta, Lewis and Mabry.

232 Social Class and Mobility. Comparative, historical analysis of causes, forms, consequences of structured social inequality in societies. Selected problems in contemporary stratification theory, research. Three hours. Danigelis, Finney, Nixon, Mabry, McCann, Mintz, Sampson, Schmidt, Stedman.

237 Occupations and Professions. Analysis

of social organization of economic roles in industrial societies, institutional relationships of occupations, professions, impact of work structure on the individual. Three hours. Finney, Folta, Mintz.

240 Political Sociology. Social organization of power, authority in modern societies and dynamics, institutional relationships of political institutions, interest groups, parties, publics. Three hours. Berkowitz, Danigelis, Finney, Nixon, Loewen, Mintz.

241 Methods of Public Opinion Research. (Same as Political Science 284.) Methods in conducting public opinion research: design, sampling, questionnaire construction, administration, data control, analysis of cross-sectional, longitudinal and time series data. *Prerequisites:* 100 (Political Science 183) or equivalent with permission of instructor. Three hours. Berkowitz, Danigelis.

242 Public Opinion: Theory and Research. (Same as Political Science 285.) Theories of public opinion. Topics: attitude formation and change, political ideology, alienation and allegiance, political socialization, tolerance, political extremism. *Prerequisite:* Sociology 241 (Political Science 284) or permission of instructor. Three hours. Bann (Political Science), Nixon, Sampson.

249 Sociology of Knowledge. Development, current status of sociological theory, research concerning emergence, roles of belief and normative systems in sociocultural organization and change. Three hours. Loewen, Sampson, Steffenhagen.

254 Sociology of Health and Medicine. Social organization, institutional relationships of medicine in society. Role of sociocultural factors in etiology, definition, identification, treatment of illness. Three hours. Berkowitz, Folta, Mabry, Stedman.

255 Sociology of Mental Health. Analysis of social structures, processes involved in identification, definition, treatment of mental illness and its sociocultural etiology, consequences. Three hours. Folta, Mabry, Steffenhagen.

258 Sociology of Law. Analysis of sociocultural structure of legal institution and its relationships to other institutions: social organization of legal profession, lawmaking, courts. Three hours. Folta, Stanfield.

274 Methods of Data Gathering in Social Research. Techniques for generating, using observational, interview, survey, existing source data to systematically test sociological ideas. Design, sampling, measurement, ethical issues. *Prerequisites:* Sociology 100 or equivalent with permission of instructor. Three hours. Berkowitz, Danigelis, Loewen, Finney, Folta, Sampson, Schmidt, Stedman.

275 Methods of Data Analysis in Social Research. Quantitative analysis of sociological data. Table, regression, path analysis, scaling and factor analysis, analysis of variance (emphasis on multivariate techniques). *Prerequisite:* Sociology 100 or equivalent with permission of instructor. Three hours. Berkowitz, Danigelis, Finney, McCann, Stedman.

278 The Development of Sociological Theory. Major classical traditions in sociological theory, contemporary research relevance. Detailed critical examination of contributions of Marx, Spencer, Durkheim, Weber, Simmel, Pareto, Mead. *Prerequisites:* Six hours of sociology or equivalent preparation in another social science with permission of instructor. Three hours. Loewen, McCann, Schmidt, Sampson.

279 Contemporary Sociological Theory. Critical examination of contemporary functional, conflict, exchange, interactionist, structural theoretical approaches. Other theoretical approaches selected by seminar participants. *Prerequisite:* Sociology 278. Three hours. Folta, McCann, Sampson.

281, 282 Seminar. Presentation, discussion of advanced problems in sociological analysis. *Prerequisites:* Twelve hours of sociology and permission of instructor. Three hours. Staff.

288, 289 Seminar: Research and Methods of Teaching Sociology. Development, evaluation of teaching sociology. *Prerequisites:* Twelve hours of sociology and permission of department. Open only to graduate students and advanced undergraduate sociology students who serve concurrently as teaching assistants in the department. Three hours. Staff.

295, 296 Special Topics.

297, 298 Readings and Research.

SPANISH

SPANISH LANGUAGE

209 Advanced Grammar. An in-depth study of Spanish grammar, its rules and practices, going beyond conventional good usage into the reasons and theories for same. Three hours. Ugalde.

SPANISH LITERATURE

235, 236 Golden Age. The picaresque novel, the drama and poetry of the 16th and 17 centuries, with emphasis on Lope de Vega, Calderon, Quevedo, Tirso de Molina. Three hours each course. Weiger. Alternate years, 1984-85.

245, 246 Cervantes. *Don Quijote,* the *Novelas Ejemplares,* and the theatre of Cervantes. Three hours each course. Weiger. Alternate years.

265 19th Century Spanish Literature. Romanticism and realism: 1. Romantic theater, prose, poetry; 2. the realist and naturalist novelists: Galdos and Leopoldo Alas. Three hours. Wesseling. Alternate years, 1983-84.

276 The Reawakening in the 20th Century. Origins and main aspects of the intellectual conflicts in modern Spain as reflected in the literary works from the "Generation of 1898" to the present. Three hours. Ugalde. Alternate years, 1983-84.

285, 286 Spanish-American Literature of Social Protest. Literature of Spanish-American peoples as a reflection of, contribution to social problems following various directions of social protest against political systems, governments, imperialism. 286 stresses the contemporary. Three hours each course. Zarate. Alternate years, 1984-85.

291 Civilization of Spain. Topical approach to the study of Spanish civilization, with emphasis on ideas, art, literature and music. Three hours. Ugalde. Alternate years, 1984-85.

293 Latin American Civilization. History, culture of Latin American people from formation of Indian civilization to present ideals, problems. Pre-Hispanic civilization, colonization, modern states. Artistic, literary, musical manifestations of these periods. Three hours. Zarate. Alternate years, 1984-85.

295, 296 Advanced Special Topics.

297, 298 Advanced Readings

TEXTILES, MERCHANDISING, AND CONSUMER STUDIES

223 Functional Apparel Design. Analysis and evaluation of the social and physical apparel needs of a variety of consumer groups; activities include discussion, experimentation, and design. *Prerequisites:* TMCS 122 or permission of instructor. 3 credit hours. Loker.

261 Consumer Education Seminar. Survey and analysis of programs, materials, and research in consumer information and education. *Prerequisites:* A research methodology course or 6 credit hours undergraduate course work in consumer studies. 3 credit hours. Scott.

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