The Graduate Catalog

university of maryland college park

The Graduate Catalog 74-75

GRADUATE SCHOOL

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Academic Calendar

SPRING 1974

January 7-11
Monday-Friday
Registration

January 9
Wednesday
Classes Begin

March 11-15
Monday-Friday
Spring recess

May 1
Wednesday
Last day of classes

May 2
Thursday
Exam study day

May 3-10
Friday-Friday
Spring semester exam period

May 12
Sunday, 3:00 P.M.
Graduation

SUMMER 1974

May 20-21
Monday-Tuesday
Registration
First Summer Session

May 22
Wednesday
Classes begin

May 27
Monday
Memorial Day holiday

June 28
Friday
Last day of classes

July 1-2
Monday-Tuesday
Registration
Second Summer Session

July 3
Wednesday
Classes begin

July 4
Thursday
Independence Day holiday

August 9
Friday
Last day of classes

FALL 1974

August 26-27
Monday-Tuesday
Registration
(Late registration proceeds August 28-30)

August 28
Wednesday
Classes begin

September 2
Monday
Labor day holiday

November 28-29
Thursday-Friday
Thanksgiving recess

December 2
Monday, 8:00 A.M.
Thanksgiving recess ends

December 11
Wednesday
Last day of classes

December 12
Thursday
Exam study day

December 13-20
Friday-Friday
Fall semester exam period

December 20
Friday, 2:00 P.M.
Graduation

SPRING 1975

January 13-14
Monday-Tuesday
Registration
(Late registration proceeds January 15-17)

January 15
Wednesday
Classes begin

February 17
Monday
Independent study day

March 26-28
Wednesday-Friday
Spring recess

April 30
Wednesday
Last day of classes

May 1
Thursday
Exam study day

May 2-9
Friday-Friday
Spring semester exam period

May 11
Sunday, 2:00 P.M.
Graduation

College Park Officers

COLLEGE PARK CAMPUS ADMINISTRATION OFFICERS

Chancellor
CHARLES E. BISHOP

Vice Chancellor for Academic Affairs
GEORGE H. CALLCOTT

Vice Chancellor for Academic Planning and Policy
THOMAS B. DAY

Vice Chancellor for Administrative Affairs
JOHN W. DORSEY

Vice Chancellor for Student Affairs
WILLIAM L. THOMAS (Acting)

ACTING DIVISION CHAIRMEN AT COLLEGE PARK

Division of Agricultural and Life Sciences
RICHARD F. DAVIS

Division of Arts and Humanities
THOMAS J. AYLWARD

Division of Behavioral and Social Sciences
MARY F. BERRY

Division of Human and Community Resources
GEORGE J. FUNARO

Division of Mathematical and Physical Sciences and Engineering
JOSEPH M. MARCHELLO

DEANS AT COLLEGE PARK

Dean of the School of Architecture
JOHN W. HILL

Dean of the College of Agriculture
GORDON M. CAIRNS

Dean of the College of Business and Management
RUDOLPH P. LAMONE

Dean of the College of Education
DONALD MALEY (Acting)

Dean of the College of Engineering
ROBERT B. BECKMANN

Dean of the College of Human Ecology
MARJORY BROOKS

Dean of the College of Journalism
RAY E. HIEBERT

Dean of the College of Library and Information Services
MARGARET E. CHISHOLM

Dean of the College of Physical Education, Recreation and Health
MARVIN H. EYLER

Administrative Dean for Academic Services and Facilities
VACANT

Administrative Dean for Graduate Studies
DAVID S. SPARKS

Administrative Dean for Summer Programs
MELVIN N. BERNSTEIN

Administrative Dean for Undergraduate Studies
ROBERT E. SHOENBERG

Graduate Studies

OFFICERS AND STAFF

DEAN FOR GRADUATE STUDIES
David S. Sparks, A.B., Grinnell College, 1944; M.A., University of Chicago, 1945; Ph.D., 1951.

ASSOCIATE DEAN FOR GRADUATE STUDIES
Gilbert W. Castellan, B.S., Regis College, 1945; Ph.D., The Catholic University of America, 1949.

ASSISTANT DEAN FOR GRADUATE STUDIES
Bernard V. Khoury, B.S., Lowell Technological Institute, 1965; Ph.D., University of Maryland, 1972.

DIRECTOR OF GRADUATE RECORDS
Carl L. Seidel, B.S., University of Maryland, 1963.

ASSISTANT TO THE DEAN
Alice M. Piper, B.A., University of Pittsburgh, 1941.

ASSISTANT TO THE DIRECTOR
Edna M. Khalil, B.A., University of Maryland, 1951.

GRADUATE COUNCIL

EX-OFFICIO MEMBERS

Chancellor Charles E. Bishop
Vice Chancellor George H. Callcott
Dean David S. Sparks
Dr. Gilbert W. Castellan

APPOINTED MEMBERS

Dr. Marjory Brooks, College of Human Ecology 1973

Dr. John O. Corliss, Department of Zoology 1975

Dr. David L. Horton, Department of Psychology 1974

Dr. Thomas J. Aylward, Division of Arts and Humanities 1973

ELECTED MEMBERS

Dr. Carl Bode, Department of English 1976

Dr. Andrew G. DeRocco, Institute for Molecular Physics 1976

Dr. Conley H. Dillon, Department of Government and Politics 1973

Dr. Marvin H. Eyler, College of Physical Education, Recreation and Health 1973

Dr. Robert G. Glasser, Department of Physics and the Computer Science Center ... 1974

Dr. Donald C. Gordon, Department of History ... 1975

Dr. Raymond L. King, Department of Dairy Science 1973

Dr. Howard J. Laster, Department of Physics ... 1973

Dr. Martin P. Reiser, Department of Electrical Engineering 1975

Dr. Charles W. Reynolds, Department of Horticulture 1974

Dr. Henry H. Walbesser, College of Education .. 1975

Dr. Howard W. Wright, Department of Business Administration 1976

EXCAVATION OF AN ANCIENT POMPEIIAN MARKET GARDEN VINEYARD
Department of History

General Information

HISTORY

The Graduate School was established in 1919 for the purpose of developing and administering programs of advanced study and research for graduate students throughout the University. At that time the Graduate School was placed under the jurisdiction of a Graduate Council acting for the Graduate Faculty with a Graduate Dean who chaired both bodies and served as the administrative officer of the Graduate School.

In 1956 the Graduate Faculty adopted a formal constitution to provide "a means for the Graduate Faculty to discharge its functions with respect to educational policies and procedures of the Graduate School." That constitution, as amended in 1968, continues to govern the policies and procedures of the Graduate School on the College Park Campus. The names of the current members of the Graduate Faculty, Graduate Council, and staff of the Graduate School will be found in appropriate places elsewhere in this catalog.

OBJECTIVES

The common goal of every graduate program, whether in the arts, the sciences, the humanities, or the professions, is to provide opportunities for intensive and individual study under outstanding members of the faculty. The Graduate School is not simply an extension or continuation of the Colleges, Schools, or Divisions, but is designed to prepare those who will dedicate themselves to individual inquiry and service. To achieve this goal it promotes an atmosphere of research and scholarship at the highest levels for both students and faculty, and it particularly stimulates the harmonious relationship between the two which leads to the advancement and transmission of knowledge.

ORGANIZATION

The Graduate Faculty, working through the Assembly and the Graduate Council, establishes policies governing admission to graduate study and minimum requirements to be met by all students seeking advanced degrees in the more than sixty graduate programs leading to degrees awarded by the Graduate School on the College Park Campus. The faculties of the individual academic departments or interdisciplinary programs frequently establish additional requirements for admission to graduate study or for individual degree programs above the minima established by the Graduate School.

The Graduate Faculty Assembly consists of all full and associate members of the Graduate Faculty whose participation in graduate instruction and research displays a capacity for individual research or creative and scholarly work at the highest levels.

The Graduate Council consists of members of the Graduate Faculty elected by the Assembly, as well as appointed and *ex officio* members. It is charged with the formulation of the policies and procedures for the Graduate School at College Park including admission standards, the review of individual student programs, the review of all new programs and courses submitted by members of the Graduate Faculty, graduate student theses and dissertations, and the periodic review of all graduate degree programs. It meets approximately eight times a year to conduct its regular business and may be called into special session as the need arises.

In its work the Graduate Council is aided and advised by nine standing committees and two *ad hoc* committees. Included are committees on: Publications; Language Requirements; Programs and Standards; Fellowships; Student Welfare; Research; Procedures and Elections; Graduate Faculty; Admissions; and Five Year Reviews of Graduate Programs. Membership on these Committees is limited to members of the Graduate Faculty and graduate students. Members are appointed by the Dean for Graduate Studies. Faculty members serve five year terms and graduate students serve one year terms. The latter are normally renewed for those students desiring longer terms who remain members of the graduate student body.

ENROLLMENT

Coming from all of the United States and from 58 foreign nations, more than 7500 graduate students enrolled in the 1972 Fall Semester. More than half of these were full-time students. During the 1972-1973 academic year, 352 Doctoral Degrees and 1,331 Master's Degrees were awarded.

LOCATION

Located on 1300 acres in Prince Georges County, eight miles from the National Capitol Building in Washington, D.C., and thirty miles from Baltimore, the

College Park Campus is in the midst of one of the greatest concentrations of research facilities and intellectual talent in the nation, if not in the world. Libraries and laboratories serving virtually every academic discipline are within easy commuting distance. There is a steady and growing interchange of ideas, information, technical skills, and scholars between the University and these centers. The libraries and facilities of many of these centers are open to qualified graduate students at the University. The resources of many more are available by special arrangement.

LIBRARIES

The University library system includes major research libraries on both the College Park and Baltimore Campuses.

The Theodore R. McKeldin Library is the graduate library of the College Park Campus, containing reference works, periodicals, circulating books, and other materials in all fields of research and instruction. Other libraries include the Engineering and Physical Sciences Library, the Architecture Library, and the Chemistry Library. A new Undergraduate Library opened in 1972.

The libraries on the College Park Campus include approximately 1,100,000 volumes and 14,000 subscriptions to periodicals and newspapers, as well as many uncatalogued government documents, phonorecords, films and filmstrips, etc.

Special collections include those of Richard von Mises in mathematics and applied mechanics; Max Born in the physical sciences; Thomas I. Cook in political science; Romeo Mansueti in the biological sciences; Katherine Anne Porter; Maryland; U.S. government publications (for which the University is a regional depository); documents of the United Nations, the League of Nations and other international organizations; agricultural experiment station and extension service publications; maps from the U.S. Army Map Service; the files of the Industrial Union of Marine and Shipbuilding Workers of America; the Wallenstein collection of musical scores; and research collections of the American Bandmasters Association, the National Association of Wind and Percussion Instructors and the Music Educators National Conference. In addition, the collections include microfilm productions of government documents, rare books, early journals, and newspapers.

But it is the combined resources of the Library of Congress, the Folger Library, Dumbarton Oaks, the National Archives, the Smithsonian Institution, the World Bank, the National Library of Medicine, the National Agricultural Library, and the libraries of the Federal Departments of Labor; Commerce; Interior; Health, Education and Welfare; Housing and Urban Development; and Transportation, and approximately 500 other specialized libraries in the area, all within a few minutes drive of the College Park Campus, that make the University of Maryland one of the most attractive in the nation for scholars of all disciplines.

SPECIAL RESEARCH RESOURCES

Exceptional research facilities are available in almost all disciplines at the University. The proximity of the Agricultural Research Center and the Plant Industry Station of the United States Department of Agriculture has stimulated the development of both laboratories and opportunities for field research in the agricultural and animal sciences. Opportunities are also available for collaborative graduate study programs with other major government laboratories, such as the National Bureau of Standards and the Naval Research Laboratory.

The long-standing interest of the State of Maryland in the commercial and recreational resources of the Chesapeake Bay has resulted in the development of outstanding research facilities for the study of marine biology at Solomons Island, Md.

Work in the behavioral sciences, particularly in learning, is centered in laboratories equipped for fully automated research on rats, pigeons, and monkeys.

Exceptional research facilities in the physical sciences include a 140 MeV cyclotron; two small Van de Graaff accelerators; an assortment of computers, including a PDP 11/45, a Univac 1106, and a Univac 1108 which is complemented by remote access units on a time-sharing basis; (the Univac 1106 and the 1108 each have 262 K of memory); a 10 KW training nuclear reactor; a full scale low velocity wind tunnel; several small hypersonic helium wind tunnels; specialized facilities in both the Institute for Molecular Physics and the Center for Materials Research; a psychopharmacology laboratory; shock tubes; a quiescent plasma device (Q machine) for plasma research; and rotating tanks for laboratory studies of meteorological phenomena. The University also owns and operates the world's longest radio telescope at Clark Lake, California.

SPECIAL OPPORTUNITIES FOR ARTISTS

Advanced work in the creative and performing arts at College Park centers in the Tawes Fine Arts Building and is greatly stimulated by the close interaction that has developed between the students and faculty of the University and the artists and scholars at the National Gallery, the Corcoran Gallery, the Phillips Gallery, the Museum of Modern Art, the Smithsonian Institution, as well as the musicians of the National Symphony Orchestra and smaller musical groups. The completion of the Kennedy Center for the Performing Arts and the Filene Center (Wolf Trap Farm Park) has further enhanced the climate for creative artists attending the University.

Outstanding work on Campus in theater, dance, radio, and television is aided by the proximity of the Campus to the National Theater, the Arena Stage, the Morris Mechanic Theater, and numerous little theater groups in the Washington and Baltimore area. There is a frequent and steady interchange of ideas and talent between students and faculty at the University and both educational and commercial radio and television media as a consequence of the large professional staffs which are maintained in the Washington area.

CONSORTIA

The University of Maryland is a member of a number of national and local consortia concerned with advanced education and research. They offer a variety of opportunities for senior scholar and graduate student research.

OAK RIDGE ASSOCIATED UNIVERSITIES, INC. (ORAU)

Oak Ridge Associated Universities, Inc., is a nonprofit educational and research corporation formed in order to broaden the opportunities for member institutions collectively to participate in many fields of education and research in the natural sciences related to nuclear energy. Educational programs range from short term courses or institutes, conducted with ORAU facilities and staff to fellowship programs administered by ORAU for the Atomic Energy Commission.

UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH (UCAR)

The National Center for Atmospheric Research (NCAR), in Boulder, Colorado, was created in 1960 to serve as a focal point for a vigorous and expanding national research effort in the atmospheric sciences. NCAR is operated under the sponsorship of the National Science Foundation by the University Corporation for Atmospheric Research (UCAR), made up of 27 U.S. universities with graduate programs in the atmospheric sciences or related fields. The scientific staff includes meteorologists, astronomers, chemists, physicists, mathematicians, and representatives of other disciplines.

UNIVERSITIES RESEARCH ASSOCIATION (URA)

Universities Research Association, a group of 50 universities engaged in high energy research, is the sponsoring organization for the National Accelerator Laboratory, funded by the U.S. Atomic Energy Commission. The accelerator, located near Batavia, Illinois, is the world's largest proton synchrotron.

INTER-UNIVERSITY COMMUNICATIONS COUNCIL (EDUCOM)

This Council provides a forum for the appraisal of the current state of the art in communications science and technology and their relation to the planning and programs of colleges and universities. The council particularly fosters inter-university cooperation in the area of communications science.

CHESAPEAKE BAY CENTER FOR ENVIRONMENTAL STUDIES (CBES)

This 900-acre waterfront research center is dedicated to preserving and enhancing the quality of man's environment through programs of ecological study and education. Located on the western shore of the Chesapeake Bay, just south of Annapolis, it presents a wide selection of local ecosystems. Scientific programs of the Center, a major component of the Smithsonian Institution, are guided by the consortium in which the University of Maryland and The Johns Hopkins University participate. The unique ecological environment provided by the Center furnishes an attractive site for graduate student research programs.

UNIVERSITIES SPACE RESEARCH ASSOCIATION (USRA)

The USRA was designed to promote cooperation between universities, research organizations, and the government in the development of space science and technology, and in the operation of laboratories and facilities for research, development and education in these fields.

INTER-UNIVERSITY CONSORTIUM FOR POLITICAL SCIENCE RESEARCH

The University of Maryland is a member of the Inter-University Consortium for Political Science Research. One purpose of the Consortium is to facilitate collection and distribution of useful data for social science research. The data includes survey data from the University of Michigan Survey Research Center and from studies conducted by other organizations or by individuals, census data for the United States, election data, legislative roll calls, judicial decision results, and biographical data.

CHESAPEAKE RESEARCH CONSORTIUM, INC.

The University of Maryland participates in this wide scale environmental research program with The Johns Hopkins University, the Virginia Institute of Marine Science, and the Smithsonian Institution. The Consortium coordinates and integrates research on the Chesapeake Bay region and is compiling a vast amount of scientific data to assist in the management and control of the area.

GRADUATE DEGREE PROGRAMS

Programs	*Degrees Offered*
Administration, Supervision and Curriculum [4, 5]	MEd, MA, AGS, EdD, PhD
Aerospace Engineering [1]	MS, PhD
Agricultural Engineering	MS, PhD
Agricultural and Extension Education [4]	MS, AGS, PhD
Agricultural and Resource Economics	MS, PhD
Agronomy	MS, PhD
American Studies	MA, PhD
Animal Science	MS, PhD
Art	MFA, MA, PhD
Astronomy [2]	MS, PhD
Botany	MS, PhD
Business Administration [6]	MBA, DBA
Chemical Engineering	MS, PhD
Chemistry	MS, PhD
Civil Engineering	MS, PhD
Comparative Literature	MA, PhD
Computer Science [3]	MS, PhD
Counseling and Personnel Services [4, 5]	MEd, MA, AGS, EdD, PhD
Criminal Justice and Criminology [1]	MA
Dairy Science	MS, PhD
Early Childhood-Elementary Education [4, 5]	MEd, MA, AGS, EdD, PhD
Economics [1]	MA, PhD
Electrical Engineering	MS, PhD
Engineering Materials	MS, PhD
English Language and Literature	MA, PhD
Entomology	MS, PhD
Food, Nutrition and Institutional Administration [3]	MS
Food Science	MS, PhD
Foundations of Education [4, 5]	MEd, MA, AGS, EdD, PhD
French Language and Literature [1]	MA, PhD
Geography [1]	MA, PhD
Germanic Language and Literature	MA, PhD
Government and Politics [1]	MA, PhD
Hearing and Speech Sciences	MA, PhD
Health Education	MA, EdD, PhD
History [1]	MA, PhD

Horticulture	MS, PhD
Human Development Education [4, 5]	MEd, MA, AGS, EdD, PhD
Human Ecology [3]	MS
Industrial Education [4, 5]	MEd, MA, AGS, EdD, PhD
Journalism [3]	MA
Library and Information Services [3]	MLS, PhD
Mathematics	MA, PhD
Mathematics, Applied	MA, PhD
Measurement and Statistics [4, 5]	MEd, MA, AGS, EdD, PhD
Mechanical Engineering [1]	MS, PhD
Meteorology	MS, PhD
Microbiology [1]	MS, PhD
Nuclear Engineering	MS, PhD
Music [1]	MM, DMA, PhD
Nutritional Sciences	MS, PhD
Philosophy [1]	MA, PhD
Physical Education	MA, EdD, PhD
Physics [2]	MS, PhD
Poultry Science	MS, PhD
Psychology [1]	MA, MS, PhD
Recreation	MA, EdD, PhD
Secondary Education [4, 5]	MEd, MA, AGS, EdD, PhD
Sociology [1]	MA, PhD
Spanish and Portuguese Languages and Literature	MA, PhD
Special Education [4, 5]	MEd, MA, AGS, EdD, PhD
Speech and Dramatic Art	MA
Textiles and Consumer Economics [3]	MS
Zoology [1]	MS, PhD

GRADUATE RECORD EXAMINATIONS:

Write to the Graduate Record Examinations, Educational Testing Service, Princeton, N.J. 08540.

[1] Both Aptitude and Advanced tests required.

[2] Advanced test only required.

[3] Aptitude test only required.

[4] Miller's Analogies Test required at the doctoral level. Write to the Counseling Center, University of Maryland, College Park, Md. 20742.

[5] The Education Test Battery: A composite examination which includes the Miller's Analogies is required for all individuals who have been admitted in the field of education. Individuals will be notified when they are to take this test battery.

[6] The Admission Test for Graduate Study in Business is required. Write to the Educational Testing Service, Box 966, Princeton, N.J. 08540.

LETTERS OF EVALUATION:

Applicants are advised that faculty admissions committees normally require two or three letters of evaluation by individuals familiar with their qualifications for successful graduate study. See the application forms for the number of such letters required. Letters of evaluation should be sent directly to the program to which the applicant seeks admission.

ADMISSION TO GRADUATE SCHOOL

GENERAL

Admission to graduate study at the College Park Campus is the responsibility of the Dean for Graduate Studies. In making decisions upon the admissibility of applicants, the Dean and his staff regularly seek the advice of the chairmen of the academic departments and graduate faculty admissions committees. In the case of foreign student applicants, the University's Director of International Education Services and Foreign Student Affairs is also consulted.

Applicants for admission to graduate study regularly exceed the number of students who can be accommodated. As a consequence every application is carefully reviewed and the number of students admitted to each program is balanced against the faculty and facilities available. As a further consequence, standards for admission vary among different programs and, at times, in the same program.

There are, however, minimum standards which apply to all applicants regardless of program or time. They have been established on the basis of long experience with those who have succeeded, as well as with those who have failed, in graduate study. They are similar to those standards governing admission to nearly all major graduate schools. The purpose of these standards is, quite simply, to distinguish between those individuals who have a reasonable expectation of successfully completing a graduate program and those individuals who would be better advised to devote their time and energies to other endeavors.

MINIMUM STANDARDS

The minimum standard for admission to The Graduate School is a "B" average, 3.0 on a 4.0 scale, in an undergraduate program of study which led to the award of a Bachelor's Degree from a college or university accredited by a regional accrediting association. In addition, the student's undergraduate program must reflect successful completion of the prerequisites for graduate study in the chosen field. Normally the "A" grades that contribute to the required "B" average will have been earned in the subject, or a closely allied one, which the student wishes to pursue in The Graduate School. A very few students, who fail to meet these minimum standards, may be admitted to graduate study as provisional students on the basis of outstanding performance on one or more of the graduate study aptitude tests, or on the basis of letters of recommendation from competent judges of their performance as students or in a professional capacity.

Standards for admission to a doctoral program are invariably higher than those for admission to a Master's Program.

EVIDENCE OF ACADEMIC POTENTIAL

For evidence of academic potential the Graduate Faculty relies heavily upon prior academic performance reflected on transcripts of previous study. Additional evidence of academic potential may take one or all of the following forms:

GRADUATE RECORD EXAMINATIONS (GRE)

Although many graduate programs do not require the GRE, most will use such test scores as an additional measurement of an applicant's qualifications. The GRE may be taken in either or both of two forms, 1) The Aptitude Test and 2) The Advanced Test. Applicants can take this test in their senior year or when filing for admission. For details, applicants should

write directly to Graduate Record Examinations, Educational Testing Service, Box 955, Princeton, New Jersey 08540.

THE ADMISSIONS TEST FOR GRADUATE STUDY IN BUSINESS (ATGSB)

Details about this test, required when applying to a program in Business Administration, can be obtained by writing to the Educational Testing Service, P.O. Box 966, Princeton, N.J. 08540.

THE MILLER'S ANALOGIES TEST (M.A.T.)

Details about the graduate form of this test can be obtained by writing to the Director, Counseling Center, University of Maryland, College Park, Md. 20742.

THE EDUCATION TEST BATTERY

Applicants for admission to programs in education will be notified when they are to take this test battery.

LETTERS OF RECOMMENDATION

All programs require three letters of recommendation for admission of all applicants at both the Master's and the Doctoral level, except the following programs which require three letters only for admission to the Doctoral program: Agricultural and Extension Education, American Studies, Business Administration, Civil Engineering, Education (all programs), Music, Spanish and Portuguese. Physical Education requires five letters at the doctoral level only. Applicants should instruct their references to send all letter of recommendation directly to the program in which they desire entrance.

Some programs require other evidence of graduate potential such as portfolios and samples of creative work, completion of specialized examinations or personal interviews.

CATEGORIES OF ADMISSION

Applicants may be offered admission to The Graduate School in any of the following three categories:

FULL GRADUATE STATUS

For admission in this category an applicant must have received a baccalaureate degree from an institution accredited by a regional accrediting association and be otherwise fully qualified in every respect.

PROVISIONAL GRADUATE STATUS

This designation may be used when (1) the previous academic record at a regionally accredited institution is borderline or when there is a lack of adequate prerequisite course work in the chosen field; (2) when the applicant has majored in another area with a creditable record but there is some doubt about his ability to pursue the program in question or (3) when the student has not yet completed his baccalaureate and so is not able to furnish a final transcript indicating the completion of all requirements and the award of the degree. A program to correct any deficiencies will be outlined by the department and the student is expected to become fully qualified within a specified time limit. When all conditions have been met, the department may recommend admission of the student to "full status." Students who are unable to qualify for full admission under the conditions specified may have their admissions terminated.

NON-DEGREE GRADUATE STATUS

Applicants who qualify for full graduate status, but who are not applicants for a degree at the University of Maryland, may be admitted in a non-degrée status for a limited time. The individual who already has an advanced degree and who wants to pursue a limited course program to gain more background in his original area or in another area of specialization would be included in this category.

Such a person is admitted on a "course-work-only" basis. Other examples: (1) a student in Education with an M.A. or M.Ed. who wants to work toward the Advanced Graduate Specialist Certificate (AGS); (2) the visitor/transfer student who is in good standing as a graduate student at another institution (See also Visitor/Transfer Student Application) and (3) the student who wishes to attend an approved National Science Foundation Institute but does not want to apply for regular admission (See also Applications for National Science Foundation Institutes).

Non-Degree Graduate Status *is not intended to be used as a qualifying program for full degree status.* While consideration may be given at a later date to the application of credits earned toward a degree program while in this status, there is no assurance that such requests will be granted. If granted, however, no more than six semester hours of credit may be transferred to a degree program.

"Course-work-only" and AGS Certificate students are admitted for a period of five years. Other non-degree students are admitted for the shorter periods specified in their offers of admission.

SPECIAL STUDENT STATUS—UNDERGRADUATE

This is an undergraduate classification and may be assigned by the Director, Admissions and Registrations (Undergraduate Division) to those applicants who have received the baccalaureate or other advanced degrees from an institution accredited by a regional accrediting association, but who do not desire or who do not qualify for graduate admission. Some graduate degree programs, notably those in the College of Education, have developed qualifying courses of study for those applicants who fall slightly below minimum standards for provisional admission. Successful completion of such program normally provides the basis for recommendation for admission to The Graduate School.

The student is warned, however, that no credit earned while in a Special Student Status may be applied at a later date to a degree program.

Special students may enroll for courses through the 500 numbered series for which they possess the necessary prerequisites. Permission from the deans of the various schools and colleges of the University is often needed to enroll as a Special Student. Courses numbered 600 or above are restricted to admitted graduate students only.

NATIONAL SCIENCE FOUNDATION INSTITUTES

During summer sessions and the regular academic year, special training programs or institutes funded by NSF are offered for the benefit of teachers and other groups with specialized short-term objectives.

Ordinarily these institutes involve only courses in the 400 series and below; hence admission as a special student, undergraduate, is all that is required. If the institute requires courses in the 600 series or higher, admission to The Graduate School is required. This admission is ordinarily on an "NSF-Institute only" basis.

ADMISSION TIME LIMITS

For master's and non-degree students, the admission terminates five years from the entrance date unless a shorter period is specified in the offer of admission; e.g. visitor/transfer students, NSF Institute students and some "course-work-only" students.

A doctoral student must be admitted to candidacy within five years after entrance, and must complete all remaining requirements within four years after admission to candidacy. The admission to the doctoral program terminates if these conditions are not met.

CHANGE OF OBJECTIVE, TERMINATION OF ADMISSION

Students are admitted only to a specified program, and within that program only for the specified objective; e.g., course work only, master's degree, doctoral degree. If the student wishes to change either the program or the objective within that program, he must submit a new application for admission. *Admission in the new status is not granted automatically.* Admission in the new status terminates the admission for the original objective.

The student's admission also terminates when the original objective has been attained; for example, the admission terminates when a student who is admitted for the master's degree completes the requirements for that degree. If the student wishes to continue for the doctorate, a new application for admission to the doctoral program must be submitted; admission to the doctoral program is not automatic but is subject to the same review process applied to others seeking admission to that program.

A student can be admitted to only one graduate program at any one time. Application for and acceptance of an offer of admission in a second graduate program automatically terminates the student's admission to the first program.

The student's admission also terminates when time limits have been exceeded or when other conditions for the continuation of the admission have not been met.

The admission of all students, both degree and non-degree, is continued at the discretion of the major professor, the department or program director, and Dean for Graduate Studies. Students must maintain an average grade of "B" or better in all graduate courses taken and must otherwise satisfy all additional departmental and Graduate School program requirements.

APPLICATION FOR ADMISSION

HOW TO APPLY

Initial correspondence concerning application for admission to The Graduate School should be addressed to:

The Graduate School,
University of Maryland
College Park, Md. 20742

An application fee of $15.00 must accompany the application for admission. This fee is *not refundable under any circumstances.* Payment must be made by check or money order payable to the University of Maryland. *Do not send cash or stamps.*

SUBMISSION OF TRANSCRIPTS

Two copies of the application for admission and two official copies of transcripts from each college or university attended must be received at The Graduate School by May 1 for the Summer and Fall Semesters and by November 1 for the Spring Semester. In some departments the available openings are filled well in advance of these deadlines so that earlier application is often desirable. Applicants who require financial support and want to be among those first considered must submit their applications by February 1 for the Fall Semester. A foreign student applicant should apply *at least seven months* prior to the semester in which the student plans to begin his studies.

Applicants for admission should instruct their institutions to send their transcripts directly to The Graduate School and not to the Registrar's Office or graduate study. Applicants who have attended any branch of the University of Maryland must also request the Registrar of the University of Maryland at that campus to send two copies of their transcript to The Graduate School, College Park Campus. All transcripts must be received at The Graduate School on or before the deadlines specified above. The applicant is *solely* responsible for seeing that all the materials have been submitted by the appropriate deadline date. No follow-up procedures are undertaken by The Graduate School in this respect.

APPLICATION IN THE SENIOR YEAR

Seniors in their final semester of work toward a Bachelor's Degree may be offered provisional admission pending the filing of a supplementary transcript recording the satisfactory completion of the remaining course work and the award of the degree. Applicants engaged in graduate study at another institution are also subject to this policy. A student faces cancellation of his admission if a complete official record of all previous work is not received within three months following the completion of such study and the award of the degree.

VISITOR/TRANSFER STUDENT APPLICATIONS

A graduate student matriculated in another graduate school, who wishes to enroll for a single summer session or a single semester in The Graduate School of the University of Maryland, and who intends thereafter to return to the graduate school in which he is

matriculated, may be admitted in a Non-Degree Graduate Status as a visiting student.

To enroll as a visitor, the student must have been officially admitted to another recognized graduate school and must be in good standing. Full transcripts of credits need not be submitted, but he must apply for admission to The Graduate School of the University of Maryland, and pay the application fee. In lieu of transcripts, he must have his graduate dean certify, in writing, to The Graduate School that he is in good standing and that the credits will be accepted toward his graduate degree. Unless otherwise specified, admission will be offered for one semester only.

APPLICATIONS FOR NATIONAL SCIENCE FOUNDATION INSTITUTES

Application for admission to an NSF Institute should be made directly to the director of the NSF Institute. If admission to The Graduate School is required, the director will apply the same criteria and standards required for admission on a regular basis in selecting qualified participants and recommending their admission to The Graduate School. Admission to a non-degree "NSF Institute only" status carries with it no implication that the individual will be automatically considered for admission in any other status at a later date. The "NSF only" status terminates upon completion of the NSF Institute in which the student was enrolled. A new application must be submitted for subsequent programs of a similar nature.

Students already admitted to a regular graduate program may also qualify for participation in an NSF Institute.

FOREIGN STUDENT APPLICATIONS

No foreign student seeking admission to the University of Maryland should plan to leave his country before obtaining an official offer of admission from the Director of Graduate Records of The Graduate School.

Academic Credentials

The complete application and official academic credentials—beginning with secondary school records—should be received by the Graduate Admissions Office *at least seven months* prior to the semester in which he plans to begin his studies. Applications may be rejected prior to this deadline when foreign student quotas have been exceeded.

English Proficiency

In addition to meeting academic requirements, the foreign student applicant must demonstrate proficiency in English by taking the Test of English as a Foreign Language (TOEFL). Because TOEFL is given only four times a year throughout various parts of the world, it is necessary for the applicant to make arrangements with the Educational Testing Service, Box 899, Princeton, N.J. 08540, to take the test as soon as he contemplates study at the University of Maryland. When the applicant is ready to begin his studies, he will be expected to read, speak, and write English fluently, to understand lectures and to take pertinent notes.

Financial Resources

A statement regarding the applicant's financial status is required by the Office of International Education Services and Foreign Student Affairs. Approximately $350.00 a month, or $4200.00 a year, is required for educational and living expenses of two academic semesters and a summer session.

A foreign student applicant must be prepared, in most cases, to meet his financial obligations from his own resources or from those provided by a sponsor for at least the first year of study, and perhaps beyond.

Immigration Documents

It is necessary for students eligible for admission to secure from the University's Director of International Education Services and Foreign Student Affairs, the immigration form required for obtaining the appropriate visa. Students already studying in the United States who wish to transfer to the University of Maryland must also secure proper immigration documents to request the Immigration and Naturalization Service to grant permission for transfer.

Reporting Upon Arrival

Every foreign student is expected to report to the Office of International Education Services and Foreign Student Affairs as soon as possible after arriving at the University. This office will be able to assist not only with various problems regarding immigration, housing, and fees, but also with more general problems of orientation to University and community life.

Questions concerning criteria and requirements for foreign applicants should be addressed to the Director, International Education Services and Foreign Student Affairs, University of Maryland, College Park, Md. 20742.

RECORDS MAINTENANCE AND DISPOSITION

All records, including academic records from other institutions, become part of the official file and can neither be returned nor duplicated for any purpose. A student should obtain an additional copy of his official credentials to keep in his possession for advisory purposes and for other personal requirements.

The admission credentials and the application data of the applicants who do not register for courses at the time for which they have been admitted or whose application has been disapproved or who do not respond to the departmental requests for additional information or whose application is not complete with respect to the receipt of all transcripts or test results are retained for one year only.

OFFER OF ADMISSION

A written offer of admission is made to an applicant who meets all admission requirements. The offer specifies the date of entrance which will normally coincide with the date requested in the application. The offer of admission must be accepted or declined by the date specified in the offer. If The Graduate School is not notified by the date specified, the offer of admission lapses and the space is reassigned to another applicant. An individual whose offer of admission has lapsed must submit a new application and fee, if he wants to be reconsidered for admission at a later date.

The offer of admission is a permit-to-register for courses, and must be presented by the student at the time of his first registration. Permanent identification as a graduate student, to be used thereafter, will be issued at the time of first registration.

GRADUATE WORK BY SENIORS AT THE UNIVERSITY OF MARYLAND

A senior at the University of Maryland who is within seven credit hours of completing the requirements for an undergraduate degree may, with the approval of his undergraduate dean (or equivalent academic officer), the head of the department concerned and The Graduate School, register in the undergraduate college for graduate courses, which may later be counted for graduate credit toward an advanced degree at the University if he has been approved for admission to The Graduate School. The total of undergraduate and graduate courses must not exceed 15 credits for the semester. Excess credits in the senior year cannot be used for graduate credit unless proper pre-arrangement is made. Seniors who wish to register for graduate credit should inquire at The Graduate School about procedure.

REGISTRATION

COURSE NUMBERING SYSTEM

Courses are designated as follows:

000 - 099	Non-credit courses.
100 - 199	Primarily freshman courses.
200 - 299	Primarily sophomore courses.
300 - 399	Junior and senior courses not acceptable for credit toward graduate degrees.
400 - 499	Junior and senior courses acceptable for credit toward some graduate degrees.
500 - 599	Professional school courses (Dentistry, Law, Medicine) and post-baccalaureate courses not for graduate degree credit.
600 - 898	Courses restricted to graduate students.
799	Master's thesis credit.
899	Doctoral dissertation credit.

The first character of the numeric position determines the level of the course and the last two digits are used for course identification. Courses ending with an 8 or 9 (third position) are courses that are repeatable for credit. All non-repeatable courses must end in 0 through 7.

Graduate credit will not be given unless the student has been admitted to The Graduate School.

REGISTRATION PROCEDURE

A *Schedule of Classes* listing courses, hours, class locations, and preregistration and registration procedures is available before the beginning of each semester. Copies may be requested from the Office of Admissions and Registrations, University of Maryland, College Park, Md. 20742.

The student's registration should reflect his involvement in graduate studies. To reflect more accurately the level of effort, a system of graduate units has been devised. The number of units per credit hour varies with the level of difficulty of the courses in the following way:

Courses in the series: 400-499 carry 4 units/credit hour.

Courses in the series: 600-898 carry 6 units/credit hour.

Research courses: 799 and 899 carry 12 units/credit hour.

A full-time student should be registered for 48 or more units in each semester. A graduate assistant is regarded as a full-time student if he registers for 24 or more units in each semester.

A student who is working full time on thesis or dissertation research must register for at least 4 credit hours of research (799 or 899) (=48 units) in each semester. This applies even if the minimum requirement of 6 hours of 799 or 12 hours of 899 has been completed.

Advisement

It is the responsibility of the student before preregistration or registration to seek advice from the department or program in which he is admitted to assure that his selection of courses will fulfill the department or program requirements.

Late Registration

Students failing to register for courses on the dates announced for the purpose can register for courses only with the consent of their advisers, The Graduate School and the Registrar. A fee of $20.00 is charged for late registration.

Pass/Fail

Graduate students are not permitted to enroll for courses on a pass/fail basis.

GRADUATE FEES *

Application Fee

This fee is not refundable $15.00

Tuition Per Credit Hour:

Resident Student $47.00

Non-Resident Student $68.00

Students admitted to The Graduate School must pay graduate tuition fees whether or not the credit will be used to satisfy program requirements. A graduate student who wishes to audit a course must pay the usual graduate tuition.

Continuous Registration Fee $10.00

Registration Fee ..... $ 5.00

Recreation Fee (Summer School Only) ..... $ 4.00

Vehicle Registration Fee $12.00

Graduation Fee, Master's Degree $15.00

Graduation Fee, Doctor's Degree $60.00

Health Fee (per semester) ..... $ 5.00

* Subject to change

RESIDENCY POLICY

The Office of the Director of Graduate Records is responsible for graduate residence classifications. In general, to become a resident for fee-paying purposes, an individual must reside in the State of Maryland as a civilian adult for at least six consecutive months not enrolled full-time in any school or college, or must furnish proof of ownership and occupancy of a home in the State of Maryland for six consecutive months.

Procedures are available for reviewing residence status. Graduate students seeking to appeal the decision concerning their residence status should contact the Office of the Director of Graduate Records.

REGISTRATION REQUIREMENT

All graduate students who are making any demands on University academic resources, e.g., using libraries, laboratories, offices, computer facilities, consulting

with adviser, taking any examination, etc., are required to register in every term (including both summer sessions) for the number of credit hours which reflects their involvement in that particular term, but in no case for less than one credit hour.

Students who are making no demands upon University resources need not register unless they have been admitted to candidacy for the doctoral degree.

CONTINUOUS REGISTRATION (DOCTORAL CANDIDATES ONLY)

After admission to candidacy for a doctoral degree every doctoral student must register in every semester until graduation. This requirement can be fulfilled in whichever of the following ways is appropriate to the individual case:

1. Students who are making demands on the University resources satisfy the Continuous Registration requirement by fulfilling, in every semester and summer term, the registration requirement described in the preceding section.
2. Students who are making no demands on University resources during the semester in question fall into two classes:
   (a) Students who have not yet registered for 12 credit hours of dissertation research (899) must fulfill the Continuous Registration requirement by registering for at least one credit hour of 899 in every semester. Students residing outside of the State of Maryland or the District of Columbia may request that the Graduate School perform the actual registration for them. The request, along with the appropriate tuition and fees should be received in the Graduate School before the end of the regular registration period for that semester. Requests received after the regular registration period and prior to the end of the eighth week of classes may be processed but are assessed a $20 late fee.
   (b) Students who have already registered for the required minimum 12 credit hours of 899 fulfill the Continuous Registration requirement by paying the $10 Continuous Registration fee in each semester until graduation. The $10 fee must be submitted, either in person or by mail, directly to the Graduate School before the end of the eighth week of classes during the fall and spring semesters.

Failure to comply with the requirement for maintaining Continuous Registration will be taken as evidence that the student has terminated his doctoral program and his admission in the Graduate School will be cancelled. A new application for admission, with the consequent re-evaluation of the student's record, will be required of a student wishing to resume a graduate program terminated in this way.

GRADES

The following symbols are used for grades: "A", "B", and "C"—Passing, "D" and "F"—Failure, and "I"—Incomplete.

Since graduate students must maintain an overall "B" average, every credit hour of "C" in course work must be balanced by a credit hour of "A". A grade of "A" in thesis research will not balance a grade of "C" in a course, nor will an "A" in transfer credit balance a "C" in a course taken at the University of Maryland. A course in which a grade of less than "B" is received may be repeated. The grade on the repeated course whether it is higher or lower than the original grade replaces the original grade. Courses in the degree program which are completed with a "D" or "F" must be repeated.

All incomplete grades must be removed before the degree is conferred. A course with an incomplete grade should not be repeated; the incomplete should be removed in all cases. Incompletes received for master's or doctoral research credits will be removed when the applicable research has been certified by the appropriate oral examination committee.

COMMENCEMENT

Application for the diploma must be filed with the Office of Admissions and Registrations within the first three weeks of the semester in which the candidate expects to obtain a degree except during summer session. During the summer session, the application must be filed during the first week of classes.

If, for any reason, a student does not graduate at the end of the semester in which he applies for the diploma he must re-apply for it in the semester in which he expects to graduate.

Academic costume is required of all candidates at commencement exercises. Those who so desire may purchase or rent caps and gowns at the Student Supply Store. Orders must be filed eight weeks before the date of commencement but may be cancelled later if the student finds himself unable to complete his work for the degree.

STUDENT SERVICES

HOUSING

The University of Maryland is not able to provide accommodations on the Campus for all graduate students although there is a limited number of apartments available to married graduate teaching and research assistants, and to a very few other married graduate students. Housing for graduate students attending Summer School is generally available. For Summer School housing only, students should apply to the Housing Office, North Administration Building, University of Maryland, College Park, Md. 20742.

An active file of off-Campus rooms and houses is available on a self-service basis to all persons. It is located in the Off-Campus Housing Office, Room 1211G, Student Union Building, University of Maryland, College Park, Md. 20742. Rooms rent from approximately $50 to $70 per month depending on the accommodations offered. There are many apartment complexes at varying rentals in the area. It is advisable to arrive at the University as far in advance of registration as possible to choose from among the more desirable locations.

The University is committed to a policy of nondiscrimination in housing for students and faculty and does not accept any listings of off-campus housing unless the owner agrees that he will not employ race, national origin, sex or religion as criteria for renting his facilities to students or faculty of the University.

HOUSING FOR MARRIED STUDENTS

The University maintains approximately 475 garden-type apartments at locations within walking distance of the campus at College Park. Although intended primarily as housing for full-time married graduate students, a limited number of efficiency apartments are available for assignment to full-time graduate students who are not married. Priority is given to teaching and research assistants. All apartments are equipped with an electric refrigerator and a gas range, but otherwise are *unfurnished*.

To be eligible for this housing, applicants and assigned residents must enroll each semester as full-time students. Inquiries about availability should be made three to six months in advance of date of need. For information, contact University of Maryland Apartments, Rental Office, 3424 Tulane Drive, Hyattsville, Md. 20783, telephone (301) 422-7445.

INFIRMARY SERVICES

Full-time graduate students enrolled for courses on the College Park Campus will have available the same infirmary services as are available to full-time undergraduate students.

FINANCIAL AID

Many departments are able to provide financial assistance in the form of teaching or research assistantships and fellowships to graduate students accepted into the department's program. Inquiries concerning the availability of such assistance should be directed to the department to which the applicant expects to be admitted or to the Fellowship and Grants Office of the Graduate School. All applicants for fellowships must be admitted to The Graduate School on a full-time basis to be eligible.

Fellowships

The Maryland Fellowship Program, established by the State Legislature and administered by The Graduate School, provides a limited number of fellowships to qualified applicants who agree to teach in a public institution of higher learning in the State of Maryland for a period of three years if a suitable position is offered after receiving either the Doctor of Philosophy or the Doctor of Education Degrees. The stipend is $2500 for the academic year with remission of tuition and fees.

Graduate Fellowships

These fellowships are awarded on a competitive basis by The Graduate School. The stipend is $1000 for the academic year, with remission of tuition and fees except for the Graduation Fee.

Assistantships

Teaching and research assistantships are also available to qualified graduate students. In addition to remission of tuition, these carry ten-month stipends ranging from $2900 to $3800. The basic twelve-month stipend level is $3600. In certain departments research assistantships with roughly comparable stipends are available. Applications for assistantships should be made directly to the department in which the applicant will study.

A substantial number of Resident Graduate Assistantships in the undergraduate residence halls are available. The stipend is $2900 per year, plus remission of tuition fees in exchange for half-time work as Residence Halls Staff members. These Resident Assistantships are open to both men and women. Applications for a Residence Graduate Assistantship should be made to the Director of Housing, University of Maryland, College Park, Md. 20742.

Offers of assistantships are made contingent upon acceptance as a graduate student by The Graduate School.

Student Loans

National Defense Education Act Loan Funds are available to graduate students of the University of Maryland. The student may request up to $2500 per year. However, because of limited funds, loans of more than $1,200 per year are rarely made. Applications should be directed to the Director, Office of Student Aid, North Administration Building, University of Maryland, College Park, Md. 20742.

DEGREE REQUIREMENTS

GRADUATE SCHOOL REQUIREMENTS APPLICABLE TO ALL MASTER'S DEGREES

In addition to the following requirements special departmental or collegiate requirements may be imposed especially in the case of those degrees which are offered only in one department or college. For these special requirements consult the descriptions which appear under the departmental or collegiate listing in this catalog or the special publications which can be obtained from the department or college.

Program

The entire course of study undertaken for any Master's degree must constitute a unified, coherent program which is approved by the student's advisor and by The Graduate School.

A minimum of thirty semester hours in courses acceptable for credit towards a graduate degree are required; in certain cases six of the thirty semester hours must be thesis research credits. The graduate program must include at least 12 hours of course work in the major subject and at least 12 hours of course work at the 600 level or higher. If the student is inadequately prepared for the required graduate courses, additional courses may be required. These courses may not be considered as part of his graduate program.

To graduate the student must have an average grade of "B" over all graduate courses taken. Courses in the program which are completed with a "D" or "F" must be repeated.

All requirements for the Master's degree must be completed within a five year period. A minimum residence of one year of full-time study at this University (or its equivalent) is required.

Transfer of Credit

A maximum of six semester hours of graduate course work taken at other regionally accredited institutions prior to matriculation in The Graduate School may be applied toward the master's degree. The courses must have been taken within the five year limit for complet-

ing the Master's degree; the department or program must agree that the specific courses are appropriate to and acceptable in the student's program; a grade of "B" or better must have been earned in such courses. (A grade of "A" in transfer work will not balance a "C" in work taken in the program here.) The request for transfer of credit shall be submitted to The Graduate School for approval at the earliest possible time. The candidate is subject to final examination by this institution in all work offered for the degree.

No credit transfer will be allowed for any courses which have been used in fulfillment of the requirements of any other degree. No credit will be granted for correspondence courses or for "credit by examination" courses.

The requirements for the degrees of Master of Arts, Master of Science and Master of Education are given immediately below. The particular requirements for the degrees of Master of Business Administration, Master of Library Science, and Master of Music are given under the corresponding program descriptions.

GRADUATE SCHOOL REQUIREMENTS FOR THE DEGREES OF MASTER OF ARTS AND MASTER OF SCIENCE

THESIS OPTION

Course Requirements

A minimum of 30 semester hours including six hours of thesis research credit (799) is required for the degrees of Master of Arts and Master of Science. Of the 24 hours required in graduate courses, not less than 12 must be earned in the major subject. Not less than one-half of the total required course credits for the degree, or a minimum of twelve, must be selected from courses numbered 600 or above.

Final Examination

The final oral examination on the thesis is conducted by a committee appointed by the Dean for Graduate Studies. The student's advisor is the chairman of the committee. The other members of the committee are persons who are familiar with the student's program of studies. The chairman and the candidate are informed of the membership of the examining committee by the Dean. The chairman of the committee then selects the exact time and place for the examination and notifies the other members of the committee and the candidate. The examination may be conducted whenever the student has completed his thesis to the satisfaction of his advisor, providing he has completed all other requirements for the degree and has a "B" average on all his graduate work. The period for the oral examination is usually about one hour, but the time should be long enough to insure an adequate examination. The report of the committee must be submitted to the Dean as soon as possible after the examination, in any event not later than the appropriate date listed in the "Important Dates for Advisors and Students" if the student is to graduate in that semester.

The examining committee also approves the thesis, and it is the candidate's obligation to see that each member of the committee has at least seven days in which to examine a copy of the thesis prior to the date of the examination. In addition to the oral examination, a comprehensive written examination may be required at the option of the major department or program committee.

NON-THESIS OPTION

The requirements for Master of Arts and Master of Science degrees without thesis vary slightly among departments and programs in which this option is available. Standards for admission are, however, identical with those for admission to any other Master's program. The quality of the work expected of the student is also identical to that expected in the thesis programs.

The general requirements for those on the non-thesis program are: a minimum of 30 semester credit hours in courses approved for graduate credit with a minimum average grade of "B" in all course work taken; a minimum of 18 semester credit hours in courses numbered 600 or above; the submission of one or more scholarly papers; and passing a written comprehensive final examination.

A student following a non-thesis Master's program will be expected to meet the same deadlines for application for a diploma and for final examination reports established for all other degree programs.

REQUIREMENTS FOR THE DEGREE OF MASTER OF EDUCATION

Nearly all departments in Education offer the Master of Education (M.Ed.) degree with the following requirements:

1. A minimum of 30 semester hours in coursework with a grade average of B. All courses with D's and F's must be repeated. Grades for courses not a part of the program but taken in graduate status will be computed in the average and are subject to the policy on D's and F's.
2. A minimum of 15 hours in courses numbered 600-800 with the remainder at least in the 400 series. Some departments require courses in departments outside of those in Education.
3. A comprehensive written examination taken at the end of coursework. A part of the examination may be oral.
4. EDMS 646 or EDMU 690 and one seminar paper; or two seminar papers.
5. EDMS 446 or EDMS 451.
6. Test battery.

For further details, see "Statement of Policies and Procedures: Master's Degrees in Education," issued by the College of Education, and descriptions of departmental programs.

ADVANCED GRADUATE SPECIALIST PROGRAM

The Advanced Graduate Specialist program is designed to promote high professional competence in an area of specialization. The candidate must be able to show that he can operate as an effective counselor, administrator, teacher, or skilled person in his major field of professional endeavor. The program is offered through most of the departments in the College of Education. The applicant must be admissible to The Graduate School but the certificate is awarded by the College of Education.

Requirements are as follows:

1. Admission based on a master's degree or its

equivalent in course hours earned either at the University of Maryland or at another institution accredited by a regional accrediting association. Applicant to be admitted in non-degree status in The Graduate School.

2. Program developed with advisor and filed with Graduate Studies office in Education.

3. Test battery required of all Education graduate students.

4. Coursework totaling not more than 30 hours (grades of B or A) from an institution accredited for graduate work, may be transferred.

5. Minimum of 60 semester hours of graduate work with not less than 30 from the University of Maryland.

6. Half of the coursework from other institutions or this University to be in courses comparable to the 600-800 series.

7. May be required to take a substantial portion of work in departments other than in Education.

8. B average with no D's or F's on the record.

9. A written examination of not less than six hours in length.

10. Registration in some kind of field study, field experience, apprenticeship or internship.

For further details see "Statement of Policies and Procedures: Advanced Graduate Specialist Program in Education," issued by the College of Education and descriptions of departmental programs.

GRADUATE SCHOOL REQUIREMENTS APPLICABLE TO ALL DOCTORAL DEGREES

In addition to the following requirements special departmental or collegiate requirements may be imposed especially in the case of those degrees which are offered only in one department or college. For these special requirements consult the descriptions which appear under the departmental or collegiate listing in this catalog or the special publications which can be obtained from the department or college.

Program

The number of credit hours required in the program varies with the degree in question.

Residence

The equivalent of three years of full-time graduate study and research is the minimum required. Of the three years the equivalent of at least one year must be spent at the University of Maryland. On a part-time basis the time needed will be increased correspondingly. All work at other institutions offered in partial fulfillment of the requirements for any doctoral degree must be submitted with the recommendation of the department or program concerned to the Graduate School for approval at the time of application for admission to candidacy. Official transcripts of the work must be on file in the Graduate School.

Admission to Candidacy

Preliminary examinations or such other substantial tests as the departments may elect are frequently prerequisite for admission to candidacy. A student must be admitted to candidacy within five years after admission to the doctoral program.

A student must be admitted to candidacy for the doctorate at least one academic year before the date on which the degree will be conferred.

Applications for admission to candidacy for the doctorate are made in duplicate by the student and submitted to his major department for further action and transmission to The Graduate School. Application forms may be obtained at the office of The Graduate School.

The student must complete all of his program for the degree, including the thesis and final examination, during a four-year period after admission to candidacy. Extensions of time are granted only under the most unusual circumstances. Failure to complete all requirements within the time allotted requires another application for admission to candidacy with the usual preliminary examination, or other prerequisites as determined by the department or program committee.

It is the responsibility of the student to submit his application for admission to candidacy when all the requirements for candidacy have been fulfilled.

Dissertation

A dissertation or its equivalent is required of all candidates for a doctoral degree. The topic of the dissertation must be approved by the department or program committee.

During the preparation of the dissertation, all candidates for any doctoral degree must register for the prescribed number of semester hours of doctoral research, numbered 899, at the University of Maryland.

Final Examination

The final oral examination is conducted by a Committee of the Graduate Faculty appointed by the Dean for Graduate Studies. The Examining Committee for the final doctoral oral examination consists of at least five voting members who hold the doctoral degree or its equivalent, at least one of whom is external to the department or program in which the student is specializing. A minimum of three members must be members of the Graduate Faculty of the University of Maryland.

One member of the Examining Committee is designated by the Dean as the Representative of the Dean for Graduate Studies.

In addition to having the normal responsibility of an examiner, the Dean's Representative has the responsibility of seeing that the examination is conducted in proper form. Any disagreement as to the conduct of the examination is referred to the Dean's Representative for decision.

One or more members of the Committee may be persons from other institutions who are distinguished scholars in the field of the dissertation.

Nominations for membership on the Committee are submitted by the student's major professor on the form certifying that the dissertation has been completed and is ready for distribution to the Committee. Complete copies of the dissertation must be distributed to the Committee at least ten days before the examination. The time and place of the examination are established by the major professor who serves as Chairman of the Committee.

All final oral examinations are open to all members of the Graduate Faculty. After the examination the committee deliberates and votes in private. Two or more negative votes constitute a failure.

The candidate may only present himself for the final oral examination twice.

Particular Requirements

The particular requirements for the Doctor of Philosophy and Doctor of Education degrees are given immediately below. The particular requirements for the degrees, Doctor of Business Administration, and Doctor of Musical Arts are given under the corresponding program descriptions.

GRADUATE SCHOOL REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

The Doctor of Philosophy Degree is granted only upon sufficient evidence of high attainment in scholarship and the ability to engage in independent research. it is not awarded for the completion of course and seminar requirements no matter how successfully completed.

Residence

See requirements for all doctoral degrees.

Foreign Language Requirement

The Graduate School no longer has a language requirement for the Doctor of Philosophy degree. However, a number of departments have retained a foreign language requirement. The student should inquire in the department regarding this requirement. The student must satisfy the departmental or program requirement before he can be admitted to candidacy for the doctorate.

Program

There is no Graduate School requirement for a specific number of course credits in either a major or a minor subject. It is the policy of The Graduate School to encourage the development of individual programs for each student who seeks the Ph.D. To that end the academic departments and interdisciplinary programs have been directed to determine major and minor requirements, levels or sequences of required courses, and similar requirements for submission to the Graduate Council for approval.

Admission To Candidacy

See requirements for all doctoral degrees.

Dissertation

The ability to do independent research must be demonstrated by an original dissertation on a topic approved by the department or program.

During the preparation of the dissertation, all candidates for the Doctor of Philosophy Degree must register for a minimum of 12 semester hours of doctoral research, numbered 899, at the University of Maryland.

Final Examination

See requirements for all doctoral degrees.

REQUIREMENTS FOR THE DEGREE OF DOCTOR OF EDUCATION

The requirements for the Doctor of Education (Ed.D.) degree are for the most part the same as those for the Doctor of Philosophy degree in Education departments in The Graduate School. The only difference lies in the amount of credit for the Ed.D. project (6-9 hours) as compared to that required for the Ph.D. dissertation (12-16 hours). For details see "Statement of Policy and Procedures: Doctoral Degrees in Education," issued by the College of Education as well as requirements for the Ph.D, see above, and departmental regulations.

SKETCHING TO SCALE

Graduate Programs

GRADUATE PROGRAMS AND COURSES

Brief descriptions of the graduate programs offered on the College Park Campus are given below. Many programs have brochures available with complete descriptions of any special admissions requirements and detailed program requirements for degrees. Requests should be directed to:

Director of Graduate Studies (program name)
Department of .....
University of Maryland
College Park, Maryland 20742

ADMINISTRATION, SUPERVISION AND CURRICULUM PROGRAM

Professor and Chairman: Stephens
Professors: J. Anderson, V. Anderson, Berman, Carbone, Dudley, James, McClure, Newell, Van Zwoll, Wedberg, Wiggin
Associate Professors: Goldman, Kelsey, McLoone,[1] Perrin
Assistant Professors: Bennett, Hempstead, Statom
[1] joint appointment with Economics

The Department of Administration, Supervision, and Curriculum offers programs of study for the MA, MEd, EdD, and PhD degrees as well as for the Advanced Graduate Specialist certificate. Areas of specialization include: administration, supervision, curriculum, higher education, and educational technology. Programs in all areas are individually designed for public or private elementary and secondary school specialists, personnel in higher education institutions or education agencies.

The department prefers that candidates have preparation and experience in teaching.

Admission at the doctoral level is based upon an academic average of 3.5 at the Master's level, performance at the 50th percentile or better on the Miller Analogies test battery and an undergraduate average of 3.0. Selective screening of qualified applicants at the Master's, AGS, and Doctoral levels is necessary in terms of limiting enrollment to the available faculty resources of the department.

The department requires at least one year of residence for a doctoral degree. A field internship is increasingly suggested for most candidates. This internship is done under faculty supervision in schools, colleges or agencies, in roles that are consistent with the candidate's program emphasis.

The department has developed close working relationships with area schools, community colleges and education agencies so that they may serve as resources for the academic offerings on campus. Procedures have been established which facilitate the use of these agencies for research and field experiences.

The Educational Technology Center in the College of Education is used extensively by students in the department, particularly those in curriculum.

EDAD 440. AUDIOVISUAL EDUCATION (3)
Sensory impressions in their relation to learning projection apparatus, its cost and operation; slides, filmstrips and films, physical principles underlying projection; auditory aids to instruction; field trips; pictures, models and graphic materials; integration of sensory aids with organized instruction. Recommended for all education students.

EDAD 441. GRAPHIC MATERIALS FOR INSTRUCTION (3)
Prerequisite, EDUC 440 or consent of instructor. A laboratory course which combines graphic and photographic processes for education and training purposes. Techniques include lettering, coloring, transparencies, illustrations, converting, duplicating transparent and opaque media. Emphasis is placed on appropriate media selection for target audiences. Heavy student project orientation.

EDAD 442. INSTRUCTIONAL MEDIA SERVICES (3)
Prerequisites, teaching experience and EDUC 440, or equivalent. Procedures for coordinating instructional media programs; instructional materials acquisition, storage, scheduling, distribution, production, evaluation and other service responsibilities; instructional materials center staff coordination of research, curriculum improvement and faculty. development programs.

EDAD 443. INSTRUCTIONAL TELEVISION UTILIZATION (3)
Combining televised lessons, on-campus seminars and related workbook assignments, this course focuses upon planning for the various uses of instructional television with students. State, local school unit, school, and classroom uses will be illustrated through film and studio production. The aspects of producing ITV programs developed through the tele-

vision lessons and "Hands-On" assignments of the seminars.

EDAD 444. PROGRAMMED INSTRUCTION (3)
Analysis of programmed instruction techniques; selection, utilization and evaluation of existing programs and teaching machines; developing learning objectives; writing and validating programs.

EDAD 489. FIELD EXPERIENCE IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in which the experience is to be taken. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field experience has been approved by the education faculty. Field experience is offered in a given area to both major and nonmajor students. *Note:* The total number of credits which a student may earn in EDAD 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDAD 498. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDAD 499. WORKSHOPS, CLINICS, INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the College of Education (or developed cooperatively with other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDAD 602. THE JUNIOR COLLEGE (3)

EDAD 603. PROBLEMS IN HIGHER EDUCATION (3)

EDAD 605. ADMINISTRATIVE FOUNDATIONS (3)
EDAD 605 is presented as the first of the four courses for students majoring in the field of educational administration, supervision, and curriculum development. It attempts to structure a theoretical and research base for the study and practice of administration in the field of education by introducing the student to selected contributors to administration, and by indicating the multidisciplinary nature of administrative study as it relates to purpose-determination, policy-definition, and task-accomplishment.

EDAD 606. ADMINISTRATIVE BEHAVIOR AND ORGANIZATIONAL MANAGEMENT (3)
A critical analysis of organizational management (informal and formal dimensions), an assessment of the contributions from other fields (traditional and emerging) to the study of administrative behavior and the governance of organizations, and an analysis and assessment of the administrator's motivations, perceptions, and sensitivity as determinants of behavior constitute the major units of study for EDAD 606. The theoretical and research bases for these areas and such related concepts as status, role, systems, interpersonal relations, and sensitivity training are examined.

EDAD 607. ADMINISTRATIVE PROCESSES (3)
EDAD 607 is designed to develop competence with respect to selected administrative process areas. It examines efforts to develop theories and models in these areas and analyzes research studies and their implications for administrative practice. In addition it seeks to develop skill in selected process areas through such techniques as simulation, role-playing, case analysis, and computer-assisted instruction.

EDAD 608. ADMINISTRATIVE RELATIONSHIPS (3)
EDAD 608 is structured to provide the student of educational administration with an understanding of the various groups and subgroups to which an administrator relates and to the significance of these relationships for leadership behavior. It provides an opportunity to examine and analyze significant principles, concepts, and issues in the areas of personnel administration, public relations, community, state, and federal agencies. The human relations skills essential to effective leadership in these areas constitute the other dimension of this course.

EDAD 611. THE ORGANIZATION AND ADMINISTRATION OF SECONDARY SCHOOLS (3)
Prerequisite, consent of instructor. The work of the secondary school principal. Includes topics such as personnel problems, school-community relationships, student activities, schedule making, and internal financial accounting.

EDAD 612. SCHOOL FINANCE AND BUSINESS ADMINISTRATION (3)
An introduction to principles and practices in the administration of the public school finance activity. Sources of tax revenue, the budget, and the function of finance in the educational program are considered.

EDAD 614. SCHOOL PLANT PLANNING (2-3)
An orientation course in which the planning of school buildings is developed as educational designing with reference to problems of site, building facilities, and equipment.

EDAD 616. PUBLIC SCHOOL SUPERVISION (3)
The nature and functions of supervision; various supervisory techniques and procedures; human relationship factors; and personal qualities for supervision.

EDAD 617. ADMINISTRATION AND SUPERVISION IN ELEMENTARY SCHOOLS (3)
Problems in administering elementary schools and improving instruction.

EDAD 625. SCHOOL PUBLIC RELATIONS (3)
A study of the interrelationship between the community and the school. Public opinion, propaganda, and the ways in which various specified agents and agencies within the school have a part in the school public relations program are explored.

EDAD 634. THE SCHOOL CURRICULUM (2-3)
A foundations course embracing the curriculum as a whole from early childhood through adolescence, including a review of historical developments, an analysis of conditions affecting curriculum change, an examination of issues in curriculum making, and a consideration of current trends in curriculum design.

EDAD 635. PRINCIPLES OF CURRICULUM DEVELOPMENT (3)
Curriculum planning, improvement, and evaluation in the schools; principles for the selection and organization of the content and learning experiences; ways of working in classroom and school on curriculum improvement.

EDAD 640. SEMINAR IN EDUCATIONAL TECHNOLOGY, RESEARCH AND THEORY (3)
Prerequisite, EDUC 642. Review of the literature, including the mass media of communications as they relate to the instructional process; learning theory implications, sociological, and economic considerations as they relate to current and future mediated instructional systems.

EDAD 642. MEDIATED INSTRUCTIONAL SYSTEMS (3)
Prerequisite, EDUC 440 and 444. Theoretical and pragmatic determinants in the selection of media systems for improving teaching-learning efficiency; development and evaluation of teaching-learning units for large-group, small-group, and self-instructional presentation; integration of print and nonprint media with team teaching techniques. Review of related research.

EDAD 644. PRACTICUM IN INSTRUCTIONAL SYSTEMS (2-6)
Prerequisite, EDUC 642. Design and application of an experimental instructional system to a problem in curriculum, learning, or research. Each student will work with school or college instructors in the development, use, and evaluation of an instructional media system to solve a specific instructional problem in the field.

EDAD 679. SEMINAR IN EDUCATIONAL ADMINISTRATION AND SUPERVISION (2-4)
Prerequisite, at least four hours in educational administration and supervision or consent of instructor. A student may register for two hours and may take the seminar a second time for an additional two hours.

EDAD 718. SCHOOL SURVEYS (2-6)
Prerequisite, consent of instructor. Includes study of school surveys with emphasis on problems of school organization and administration, finance and school plant planning; field work in school surveys is required.

EDAD 721. ADVANCED SCHOOL PLANT PLANNING (2)
EDAD 614 is a prerequisite to this course. However, students with necessary background may be admitted without completion of EDAD 614. Emphasis is given to analysis of the educational program and planning of physical facilities to accommodate that program.

EDAD 723. PRACTICUM IN PERSONNEL RELATIONSHIPS (2-6)
Prerequisite, Master's Degree or consent of instructor. Prerequisite may be waived with advisor's approval. Enrollment limited. Designed to help teachers, school administrators, and other school staff members to learn to function more effectively in developing educational policy in group situations. Each student in the course is required to be working concurrently in the field with a group of school staff members or citizens on actual school problems.

EDAD 726. CHILD ACCOUNTING (2)
An inquiry into the record keeping activities of the school system, including an examination of the marking system.

EDAD 727. PUBLIC SCHOOL PERSONNEL ADMINISTRATION (3)
A comparison of practices with principles governing the satisfaction of school personnel needs, including a study of tenure, salary schedules, supervision, rewards, and other benefits.

EDAD 750. ORGANIZATION AND ADMINISTRATION OF TEACHER EDUCATION (3)
Teacher education today—current patterns and significant emerging changes, particularly those involving teachers and schools. Deals with selection, curriculum, research, accreditation, and institution-school relationships.

EDAD 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number.

EDAD 799. MASTER'S THESIS RESEARCH (1-6)
Six hours required for master's thesis.

EDAD 802. CURRICULUM IN HIGHER EDUCATION (3)
Analysis of research in curriculum and of conditions affecting curriculum change, with examination of issues in curriculum making based upon the history of higher education curriculum development.

EDAD 803. ORGANIZATION AND ADMINISTRATION OF HIGHER EDUCATION (3)
Organization and administration of higher education at the local, state, and federal levels; and an analysis of administrative relationships and functions and their effects in curriculum and instruction.

EDAD 805. COLLEGE TEACHING (3)
Various methods of college instruction analyzed in relation to the curriculum and psychological basis. These would include the case study method, the demonstration method, the lecture method, the recitation method, teaching machines, teaching by television, and other teaching aids.

EDAD 806. SEMINAR IN PROBLEMS OF HIGHER EDUCATION (2)

EDAD 837. CURRICULUM THEORY AND RESEARCH (2)

EDAD 858. ADULT EDUCATION (3)

EDAD 859. SEMINAR IN ADULT EDUCATION (3)

EDAD 879. SEMINAR IN TEACHER EDUCATION (3-6)
A problem seminar in teacher education. A maximum of six hours may be earned in this course.

EDAD 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's degree in Education, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDAD 489, 888 and 889 is limited to a maximum of 20 semester hours.

EDAD 889. INTERNSHIP IN EDUCATION (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the doctor's degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *Note:* The total number of credits which a student may earn in EDAD 489, 888 and 889 is limited to a maximum of 20 semester hours.

EDAD 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an Ed.D. project and 12-18 hours required for a Ph.D. dissertation.

AEROSPACE ENGINEERING PROGRAM

Professor and Chairman: Anderson
Professors: Corning, Melnik, Rivello, Sherwood
Associate Professors: Donaldson, Jones, Plotkins, Schaeffer
Assistant Professors: Barlow, Weisshaar
Lecturers: Billig, Fleig, Wilson

The Aerospace Engineering Department offers a broad program of graduate studies leading to the degrees of Master of Science and Doctor of Philosophy. The curricula for these degrees are adapted to meet the objectives and background of the individual student and are planned by the student and his advisor. Aerodynamics and Propulsion, Structural Mechanics, and Flight Dynamics are the major areas of specialization available to graduate students.

Applications for admission are accepted from those holding a B.S. degree in engineering, the physical sciences, and mathematics. However, applicants with undergraduate degrees in fields other than Aerospace Engineering will be required to correct deficiencies in prerequisite undergraduate coursework before enrolling in graduate courses.

Two master's degree options are available: thesis and non-thesis. No special departmental requirements are imposed beyond The Graduate School requirements.

Requirements for the Doctor of Philosophy degree beyond The Graduate School requirements include two semesters residence (or equivalent); three years of full-time graduate study (or equivalent); 48 semester hours of coursework beyond the B.S. including (1) not less than 18 hours within one departmental area of specialization, (2) not less than 9 hours from among the other areas of specialization in the department, (3) not less than 12 hours in courses which emphasize the physical sciences or mathematics rather than their applications. The total in (2) plus that in (3) must be at least 24 hours of which no more than 6 are less than 600 level. Written and oral comprehensive examinations are also required.

The research facilities of the department are available to the graduate student. The aerodynamic facilities include two subsonic, two supersonic, and a hypersonic wind tunnel. Facilities are also available for static and vibration testing of structures. An assortment of computers including an IBM 7094, two 1401's, and a Univac 1108 complemented by remote access units on a time-sharing basis are available. Under special circumstances thesis research may be accomplished in off-campus research facilities.

ENAE 401. AEROSPACE LABORATORY II (2)
One lecture and one laboratory per week. Prerequisites, ENAE 305 and ENAE 345. Corequisites, ENAE 352 and ENAE 471. Required of seniors in aerospace engineering. Application of fundamental measurement techniques to experiments in aerospace engineering. Structural, aerodynamic, and propulsion tests. Correlation of theory with experimental results.

ENAE 402. AEROSPACE LABORATORY III (1)
One laboratory per week. Prerequisites, ENAE 305 and ENAE 345. Corequisites, ENAE 352, ENAE 471, and ENAE 475. Application of fundamental measurement techniques to experiments in aerospace engineering. Structural, aerodynamic, flight simulation, and heat transfer tests. Correlation of theory with experimental results.

ENAE 411. AIRCRAFT DESIGN (3)
Two lectures and one laboratory period each week. Prerequisites, ENAE 345, ENAE 351 and ENAE 371. Design elective for seniors in aerospace engineering. Theory, background and methods of airplane design, subsonic, supersonic and VSTOL.

ENAE 412. DESIGN OF AEROSPACE VEHICLES (3)
Two lectures and one laboratory per week. Prerequisites, ENAE 345 and ENAE 371. Design elective for seniors in aerospace engineering. Theory, background and methods of space vehicle design for

manned orbiting vehicles, manned lunar and Martian landing systems.

ENAE 445. DYNAMICS OF AEROSPACE VEHICLES (3)
Three lectures per week. Prerequisites, ENAE 345 and ENAE 371. Dynamics elective for senior students in aerospace engineering. Stability, control and miscellaneous topics in dynamics.

ENAE 455. AIRCRAFT VIBRATIONS (3)
Three lectures per week. Prerequisite, ENAE 345. Corequisite, ENAE 352. Dynamics elective for senior students in aerospace engineering. Vibrations and other dynamic problems occurring in aerospace structures. Study topics include free and forced vibrations of single and multiple degree of freedom systems, and of continuous systems.

ENAE 457. FLIGHT STRUCTURES III (3)
Three lectures each week. Prerequisite, ENAE 352 or equivalent. Elective for seniors in aerospace engineering. An advanced undergraduate course dealing with the theory and analysis of the structures of flight vehicles. Topics will include, stresses due to shear, indeterminate structures, matrix methods, plate theory, buckling and failure of plates.

ENAE 461. FLIGHT PROPULSION I (3)
Two lectures and one laboratory per week. Prerequisites, ENME 216 and ENAE 471. Required of seniors in aerospace engineering. Operating principles of piston, turbojet, turboprop, ramjet and rocket engines. Thermodynamic cycle analysis and engine performance. Aerothermochemistry of combustion, fuels, and propellants.

ENAE 462. FLIGHT PROPULSION II (3)
Two lectures and one laboratory per week. Prerequisite, ENAE 461. Elective for seniors in aerospace engineering. Extension of material in ENAE 461. Advanced and current topics in flight propulsion.

ENAE 471. AERODYNAMICS II (3)
Three lectures per week. Prerequisites, ENAE 371 and ENME 216. Required of seniors in aerospace engineering. Elements of compressible flow with applications to aerospace engineering problems.

ENAE 472. AERODYNAMICS III (3)
Three lectures per week. Prerequisite, ENAE 371. Elective for seniors in aerospace engineering. Theory of the flow of an incompressible fluid.

ENAE 473. AERODYNAMICS OF HIGH SPEED FLIGHT (3)
Three lectures per week. Prerequisite, ENAE 372 or equivalent. Elective course for seniors in aerospace engineering. An advanced course dealing with aerodynamic problems of flight at supersonic and hypersonic velocities. Topics will include unified hypersonic and supersonic small disturbance theories, real gas effects, aerodynamic heating and mass transfer with applications to hypersonic flight and re-entry.

ENAE 475. VISCOUS FLOW AND AERODYNAMIC HEATING (3)
Three lectures per week. Prerequisites, ENAE 371, ENAE 472, and ENME 216. Required course for aerospace seniors. Fundamental aspects of viscous flow. Navier-Stokes equations, similarity, boundary layer equations; laminar, transitional and turbulent incompressible flows on airfoils, thermal boundary layers and convective heat transfer. Conduction through solids. Introduction to radiative heat transfer.

ENAE 488. TOPICS IN AEROSPACE ENGINEERING (1-4)
Technical elective taken with the permission of the student's advisor and instructor. Lecture and conference courses designed to extend the student's understanding of aerospace engineering. Current topics are emphasized.

ENAE 499. ELECTIVE RESEARCH (1-3)
May be repeated to a maximum of three credits. Elective for seniors in aerospace engineering with permission of the student's advisor and the instructor. Original research projects terminating in a written report.

ENAE 651. ADVANCED FLIGHT STRUCTURES (3)
Prerequisites, MATH 246 and ENAE 351, 352 or permission of the instructor. Advanced topics in structural theory with applications to flight vehicle structures. Energy and matrix methods, plate theory, instability and failure of columns, plates, and stiffened panels; introduction to shell theory.

ENAE 652. ADVANCED FLIGHT STRUCTURES (3)
See ENAE 651, above.

ENAE 655. STRUCTURAL DYNAMICS AND AEROELASTICITY (3)
Prerequisites, MATH 246 and ENAE 352. Generalized coordinates and Lagrange's equations. Vibrations of simple systems. Dynamics of elastically connected masses. Influence coefficients. Mode shapes and principal oscillations. Matrix methods of structural response. Transient stresses in an elastic structures. Wing divergence and aileron reversal. Theory of two dimensional oscillating airfoil. Flutter problems. Random vibrations.

ENAE 656. STRUCTURAL DYNAMICS AND AEROELASTICITY (3)
See ENAE 655, above.

ENAE 661. ADVANCED PROPULSION (3)
Prerequisites, ENAE 461, 462. Special problems of thermodynamics and dynamics of aircraft power plants; jet, rocket and ramjet engines. Plasma, ion and nuclear propulsion for space vehicles.

ENAE 662. ADVANCED PROPULSION (3)
See ENAE 661, above.

ENAE 671. AERODYNAMICS OF INCOMPRESSIBLE FLUIDS (3)
Prerequisite, MATH 463, or permission of instructor. Fundamental equations in fluid mechanics. Irrotational motion. Circulation theory of lift. Thin airfoil theory. Lifting line theory. Wind tunnel corrections. Perturbation methods.

ENAE 672. AERODYNAMICS OF INCOMPRESSIBLE FLUIDS (3)
See ENAE 671, above.

ENAE 673. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3)
Prerequisite, ENAE 471 or permission of instructor. One dimensional flow of a perfect compressible fluid. Shock waves. Two-dimensional linearized theory of compressible flow. Two-dimensional transonic and hypersonic flows. Exact solutions of two dimensional isotropic flow. Linearized theory of three-dimensional potential flow. Exact solution of axially symmetrical potential flow. One-dimensional flow with friction and heat addition.

ENAE 674. AERODYNAMICS OF COMPRESSIBLE FLUIDS (3)
See ENAE 673, above.

ENAE 675. AERODYNAMICS OF VISCOUS FLUIDS (3)
Derivation of Navier-Stokes equations, some exact solutions: boundary layer equations. Laminar flow-similar solutions, compressibility, transformations, analytic approximations, numerical methods, stability and transition of turbulent flow. Turbulent flow-isotropic turbulence, boundary layer flows, free mixing flows. (This course is equivalent to ENME 644).

ENAE 676. AERODYNAMICS OF VISCOUS FLUIDS (3)
See ENAE 675, above. (This course is equivalent to ENME 645).

ENAE 688. SEMINAR (1-16)
ENAE 756. ADVANCED STRUCTURAL DYNAMICS I (3)
Advanced topics in structural dynamics analysis: dynamic properties of materials, impact and contact phenomena, wave propagation, numerical methods for complex structural systems, analysis for wind and blast loads, penetration loads, and earthquake, nonlinear systems, random vibrations and structural failure from random loads. (This course is equivalent to ENME 760).

ENAE 757. ADVANCED STRUCTURAL DYNAMICS II (3)
See ENAE 756, above. (This course is equivalent to ENME 761).

ENAE 776. HEAT TRANSFER PROBLEMS ASSOCIATED WITH HIGH VELOCITY FLIGHT (3)
Prerequisite, permission of instructor. Heat conduction in solids and thermal radiation of solids and gases. Analytic solutions to simple problems and numerical methods for solving complicated problems. Convective heating associated with laminar and turbulent boundary-layer flow. Heat transfer equations are derived for the plate case and for selected body shapes such as cones and hemispheres. Real gas effects on convective heating are examined.

ENAE 777. HEAT TRANSFER PROBLEMS ASSOCIATED WITH HIGH VELOCITY FLIGHT (3)
See ENAE 776, above.

ENAE 788. SELECTED TOPICS IN AEROSPACE ENGINEERING (3)

ENAE 789. SELECTED TOPICS IN AEROSPACE ENGINEERING (3)

ENAE 799. MASTER'S THESIS RESEARCH (1-6)

ENAE 899. DOCTORAL DISSERTATION RESEARCH (1-8)

AFRO-AMERICAN STUDIES COURSES

AASP 400. DIRECTED READINGS IN AFRO-AMERICAN STUDIES (3)
The readings will be directed by the Director of Afro-American studies. Topics to be covered will be chosen by the Director to meet the needs and interests of individual students.

AASP 401. SEMINAR IN AFRO-AMERICAN STUDIES (3)
The theory and concepts of the social and behavioral sciences as they relate to Afro-American studies. Required for the certificate in Afro-American studies. Prerequisites: at least 15 hours of Afro-American studies, related courses or permission of the Director.

AASP 403. THE DEVELOPMENT OF A BLACK AESTHETIC (3)
An analysis of selected areas of black creative expression in the arts for the purpose of understanding the informing principles of style, techniques, and cultural expression which make up a Black Aesthetic. Prerequisite: Completion of ENGL 443 or AASP 302 or consent of instructor.

AASP 411. NINETEENTH CENTURY BLACK RESISTANCE MOVEMENTS (3)
A comparative description of the black resistance movements in Africa and America during the Nineteenth Century; analysis of their relationship, similarities and dissimilarities as well as their impact on Twentieth Century black nationalism.

AASP 428. SPECIAL TOPICS IN BLACK DEVELOPMENT (3)
A multi-disciplinary and inter-disciplinary educational experience concerned with questions relevant to the development of black people everywhere. Development implies political, economic, social, and cultural change, among other things. Consequently, a number of topics may be examined and studied.

AASP 429. SPECIAL TOPICS IN BLACK CULTURE (3)
An interdisciplinary approach to the role of black artists around the world. Emphasis is placed upon contributions of the black man in Africa, the Caribbean and the United States to the literary arts, the musical arts, the performing arts, and the visual arts. Course content will be established in terms of those ideas and concepts which reflect the cultural climate of the era in which they were produced. Attention to individual compositions and works of art through lectures, concepts, field trips, and audio-visual devices.

AGRICULTURAL ENGINEERING PROGRAM

Professor and Acting Chairman: Harris
Professors: Green, Winn

Associate Professors: Cowan, Felton, Hummel, Merkel
Assistant Professor: Rebuck

The Department of Agricultural Engineering offers a graduate program of study with specialization in either agricultural or aquacultural engineering leading to the degrees of Master of Science and Doctor of Philosophy. The program of study is planned on a personal basis and is oriented towards the intellectual and professional objectives of the student.

Courses and research problems place emphasis on the engineering aspects of the production, harvesting, processing and marketing of terrestrial and aquatic food and fiber products, with concern for the conservation of land and water resources and the utilization and/or disposal of by-products associated with biological systems in order to maintain and enhance the quality of our environment while contributing to efficient production of food and fiber to meet increasing population demands.

Only the thesis option is available for the M.S. degree. The department has no language requirement for either the M.S. or Ph.D. degree.

In addition to well-equipped laboratories in the department, the facilities of the Agricultural Experiment Station, the Computer Science Center, and the College of Engineering are available. The new University of Maryland Center for Environmental and Estuarine Studies will enhance the aquacultural phase of the department's graduate program.

AGEN 401. AGRICULTURAL PRODUCTION EQUIPMENT (3)
First semester. Two lectures and one laboratory per week. Prerequisite, AGEN 100. Principles of operation and functions of power and machinery units as related to tillage; cutting, conveying, and separating units; and control mechanisms. Principles of internal combustion engines and power unit components.

AGEN 402. AGRICULTURAL MATERIALS HANDLING AND ENVIRONMENTAL CONTROL (3)
Second semester. Two lectures and one laboratory per week. Prerequisite, AGEN 100. Characteristics of construction materials and details of agricultural structures. Fundamentals of electricity, electrical circuits, and electrical controls. Materials handling and environmental requirements of farm products and animals.

AGEN 421. POWER SYSTEMS (3)
First semester. Two lectures and one two hour laboratory per week. Prerequisites, ENME 216, ENEE 300 and ENME 340. Analysis of energy conversion devices including internal combustion engines, electrical and hydraulic motors. Fundamentals of power transmission and coordination of power sources with methods of power transmission. (Harris)

AGEN 422. SOIL AND WATER ENGINEERING (3)
Second semester. Three lectures per week, prerequisite, ENME 342. Applications of engineering and soil sciences in erosion control, drainage, irrigation and watershed management. Principles of agricultural hydrology and design of water control and conveyance systems. (Rebuck)

AGEN 424. FUNCTIONAL AND ENVIRONMENTAL DESIGN OF AGRICULTURAL STRUCTURES (3)
Second semester. Two lectures and one 2-hour laboratory per week. Prerequisites, AGEN 324. An analytical approach to the design and planning of functional and environmental requirements of plants and animals in semi- or completely enclosed structures. (Merkel)

AGEN 433. ENGINEERING HYDROLOGY (3)
First semester. Three lectures per week. Prerequisites, MATH 246, ENCE 330 or ENME 342. Properties, distribution and circulation of water from the sea and in the atmosphere emphasizing movement overland, in channels and through the soil profile. Qualitative and quantitative factors are considered. (Rebuck)

AGEN 435. AQUACULTURAL ENGINEERING (3)
Spring semester. Prerequisite, consent of department. A study of the engineering aspects of development, utilization and conservation of aquatic systems. Emphasis will be on harvesting and processing aquatic animals or plants as related to other facets of water resources management. (Wheaton)

AGEN 489. SPECIAL PROBLEMS IN AGRICULTURAL ENGINEERING (1-3)
Prerequisite, approval of department. Student will select an engineering problem and prepare a technical report. The problem may include design, experimentation, and/or data analysis.

AGEN 499. SPECIAL PROBLEMS IN FARM MECHANICS (1-3)
Prerequisite, approval of department. Not acceptable for majors in agricultural engineering. Problems assigned in proportion to credit.

AGEN 601. INSTRUMENTATION SYSTEMS (3)
Prerequisite, approval of department. Analysis of instrumentation requirements for research and operational agricultural or biological systems. (Winn)

AGEN 602. MECHANICAL PROPERTIES OF BIOLOGICAL MATERIALS (3)
Prerequisite, differential equations. A study of the significance and the utilization of the mechanical properties of biological materials under various conditions of loading. Emphasis on particle motion; relationships between stress and strain, force, velocity and acceleration; principles of work and energy, and theories of failure.

AGEN 603. BIOLOGICAL PROCESS ENGINEERING (3)
First semester. Prerequisite, differential equations. Interrelationships of physical properties as functions of moisture and temperature gradients in agricultural and aquacultural materials. (Cowan)

AGEN 605. LAND AND WATER RESOURCE DEVELOPMENT ENGINEERING (3)
First semester. Prerequisite, AGEN 422 or approval of department. A comprehensive study of engineering aspects of orderly development for land and water resources. Emphasis will be placed on project formulation, data acquisition, project analysis and engineering economy. (Rebuck)

AGEN 688. ADVANCED TOPICS IN AGRICULTURAL ENGINEERING (1-4)
Prerequisite, consent of instructor. Advanced topics of current interest in the various areas of agricultural engineering. Maximum eight credits.

AGEN 698. SEMINAR (1)
First and second semesters.

AGEN 699. SPECIAL PROBLEMS IN AGRICULTURAL AND AQUACULTURAL ENGINEERING (1-6)
First and second semester and summer school. Work assigned in proportion to amount of credit.

AGEN 799. MASTER'S THESIS RESEARCH (1-6)

AGEN 899. DOCTORAL DISSERTATION RESEARCH (1-8)

AGRICULTURAL AND EXTENSION EDUCATION PROGRAM

Acting Chairman: Poffenberger
Professors: Longest, Ryden
Associate Professors: Nelson, Smith

As a multidisciplinary department of several educational and social science specialties, the Department of Agricultural and Extension Education services the academic and continuing education needs and interests of the Cooperative Extension Service, teachers of agriculture and professionals involved in community development.

The Master of Science and Doctor of Philosophy degree and the Advanced Graduate Specialist Certificate may be obtained in options in Agricultural Education, Extension and Continuing Education, and Community Development. Specialization options in Agricultural Education include teacher education, research, and administration and supervision. Specialization options under Extension and Continuing Education include personnel development, program development, administration and supervision, and continuing education. The multidisciplinary Community Development program specialties include various social science disciplines with research, teaching, and extension functions; human and organizational planning and development; and public affairs education an optional emphasis.

In the Master of Science degree programs both thesis and non-thesis options are available. Applicants for the Master of Science program must present transcripts for evaluation.

As a continuing education option the department offers the A. G. S. program leading to the Advanced Graduate Specialist Certificate. It requires 30 credits beyond the Master's degree.

No specific number of credits is required for the Doctor of Philosophy degree. Each student's program is planned by his committee according to his previous education and experience, special interests and needs, and professional plans. No foreign language requirement exists but is optional and encouraged for those interested in international development areas. Students are usually encouraged to develop additional research techniques through specific courses and participation in department research programs. Two consecutive semesters of full-time resident study are required. Applicants should present results of the Graduate Education Test Battery (Miller Analogies, Cooperative English, and SCAT quantitative tests) with their applications for admission.

For other requirements and guidelines concerning the above programs, contact the Department of Agricultural and Extension Education.

RLED 422. EXTENSION EDUCATION (3)
Studies the many facets of the cooperative extension service: philosophy, objectives, policies, organization, legislation, and methods used. Emphasis will be placed on the Cooperative Extension Service as an educational agency.

RLED 423. EXTENSION COMMUNICATIONS (3)
Deals with the scope and purpose of communication factors involved in the process and how it affects human behavior. This behavioral approach to communication directs its emphasis toward interpersonal communication, social systems, the mass media, and other related fields, with special attention to extension.

RLED 426. DEVELOPMENT AND MANAGEMENT OF EXTENSION YOUTH PROGRAMS (3)
Designed for present and prospective state leaders of extension youth programs—program development, principles of program management, leadership development and counseling; science, career selection and citizenship in youth programs, field experience in working with low income families' youth, urban work.

RLED 464. RURAL LIFE IN MODERN SOCIETY (3)
Examination of the many aspects of rural life that affect and are affected by changes in technical, natural and human resources. Emphasis is placed on the role which diverse organizations, agencies and institutions play in the education and adjustment of rural people to the demands of modern society.

RLED 466. RURAL POVERTY IN AN AFFLUENT SOCIETY (3)
Topics examined include conditions under which people in poverty exist, factors giving rise to such conditions, problems faced by the rural poor, and the kinds of assistance they need to rise out of poverty. Topics and issues are examined in the context of rural-urban interrelationships and their effects on rural poverty. Special attention is given to past and present programs designed to alleviate poverty and to considerations and recommendations for future action.

RLED 487. CONSERVATION OF NATURAL RESOURCES (3)
Designed primarily for teachers. Study of state's natural resources—soil, water, fisheries, wildlife, forests, and minerals—natural resources problems and practices. Extensive field study. Concentration on subject matter. Taken concurrently with RLED 497 in summer session.

RLED 488. CRITIQUE IN RURAL EDUCATION (1)
Current problems and trends in rural education.

RLED 489. CRITIQUE IN RURAL EDUCATION (1)
Current problems and trends in rural education.

RLED 497. CONSERVATION OF NATURAL RESOURCES (3)
Designed primarily for teachers. Study of state's natural resources—soil, water, fisheries, wildlife, forests, and minerals—natural resources problems and practices. Extensive field study. Methods of teaching conservation included. Taken concurrently with RLED 487 in summer session.

RLED 499. SPECIAL PROBLEMS (1-3)
Prerequisite, staff approval.

RLED 606. PROGRAM PLANNING AND EVALUATION IN AGRICULTURAL EDUCATION (2-3)
Analysis of community agricultural education needs, selection and organization of course content, criteria and procedures for evaluating programs.

RLED 626. PROGRAM DEVELOPMENT IN EXTENSION EDUCATION (3)
Concepts in program planning and development. A conceptual approach to a tested framework for programming. Study and analysis of program design and implementation in the Cooperative Extension Service.

RLED 628. SEMINAR IN PROGRAM PLANNING (1-5)
The student assists in the development of an educational program in an institutional or community setting. He also develops an individualized unit of study applicable to the program. Seminar sessions are based on the actual problems of diagnosing needs, planning, conducting, and evaluating programs.

RLED 642. CONTINUING EDUCATION IN EXTENSION (3)
Studies of the process through which adults have and use opportunities to learn systematically under the guidance of an agent, teacher or leader. A variety of program areas will be reviewed giving the student an opportunity to plan, conduct and evaluate learning activities for adults.

RLED 661. RURAL COMMUNITY ANALYSIS (3)
First semester. Analysis of structure and function of rural society and application of social understandings to educational processes.

RLED 663. DEVELOPING RURAL LEADERSHIP (2-3)
First semester. Theories of leadership are emphasized. Techniques of identifying formal and informal leaders and the development of rural lay leaders.

RLED 689. SPECIAL TOPICS IN RURAL EDUCATION (2)

RLED 691. RESEARCH METHODS IN RURAL EDUCATION (2-3)
First semester. The scientific method, problem identification, survey of research literature, preparing research plans, design of studies, experimentation, analysis of data and thesis writing.

RLED 699. SPECIAL PROBLEMS (1-3)
Prerequisite, approval of staff.

RLED 707. SUPERVISION OF STUDENT TEACHING (1)
Summer session. Identification of experiences and activities in an effective student teaching program, responsibilities and duties of supervising teachers, and evaluation of student teaching.

RLED 789. SPECIAL TOPICS IN RURAL EDUCATION (2)

RLED 798. SEMINAR IN RURAL EDUCATION (1)
Second semester. Problems in the organization, administration, and supervision of the several agencies of rural education. Investigation, papers, and reports.

RLED 799. MASTER'S THESIS RESEARCH (1-6)
RLED 882. AGRICULTURAL COLLEGE INSTRUCTION (1)

RLED 899. DOCTORAL DISSERTATION RESEARCH (1-8)

AGRICULTURAL AND RESOURCE ECONOMICS PROGRAM

Professor and Chairman: Curtis
Professors: Beal, Bender, Foster, Ishee, Lessley, Moore, Murray, Poffenberger, Smith, Stevens, Tuthill, Wysong
Associate Professors: Bell (visiting), Bender, Cain, Hardie, Holmes, Lawrence, Via
Assistant Professors: Holmes, Lawrence, Marasco, Nash (visiting)

The Department of Agricultural and Resource Economics offers graduate programs of study leading to the degrees of Master of Science and Doctor of Philosphy. Both thesis and non-thesis options are available for the Master of Science degree. Publications containing the detailed requirements for each degree are available from the department.

Students may pursue major work in production economics, foreign economic development, international trade, agricultural marketing, resource development economics, resource management, public policy, and fisheries economics. The various programs offer research and/or internship experiences designed to give competency in making observations from the real world, coursework to familiarize the student with traditional subject matter as well as the frontiers of knowledge, and seminar and discussion opportunities to enable the student to sharpen his ability to express his thoughts.

AREC 404. PRICES OF AGRICULTURAL PRODUCTS (3)
An introduction to agricultural price behavior. Emphasis is placed on the use of price information in the decision-making process, the relation of supply and demand in determining agricultural prices, and the relation of prices to grade, time, location, and stages of processing in the marketing system. The course includes elementary methods of price analysis, the concept of parity and the role of price support programs in agricultural decisions
(Marasco)

AREC 406. FARM MANAGEMENT (3)
The organization and operation of the farm business to obtain an income consistent with family resources and objectives. Principles of production economics and other related fields are applied to the individual farm business. Laboratory period will be largely de-

voted to field trips and other practical exercises. (Lessley)

AREC 407. FINANCIAL ANALYSIS OF THE FARM BUSINESS (3)
Application of economic principles to develop criteria for a sound farm business, including credit source and use, preparing and filing income tax returns, methods of appraising farm properties, the summary and analysis of farm records, leading to effective control and profitable operation of the farm business. (Wysong)

AREC 414. INTRODUCTION TO AGRICULTURAL BUSINESS MANAGEMENT (3)
The different forms of businesses are investigated. Management functions, business indicators, measures of performance, and operational analysis are examined. Case studies are used to show applications of management techniques. (Lessley)

AREC 416. MARKETING MANAGEMENT OF AGRI-BUSINESS ENTERPRISES (3)
Prerequisite, AREC 414 or permission of instructor. Principles, functions, institutions and channels of marketing viewed from the perspective of a manager of an agricultural business enterprise. The managerial framework for analyzing the entire marketing program of a firm is developed and utilized. (Cain)

AREC 427. AGRICULTURAL COMMODITY MARKETS —AN ECONOMIC ANALYSIS (3)
Problems, institutions and functions within marketing systems for poultry and eggs, dairy, grain, horticultural, livestock, tobacco and forestry products. Practical applications of elementary economic theory in a framework for analysis of market problems. (Via)

AREC 432. AGRICULTURAL POLICY AND PROGRAMS (3)
A study of public policies and programs related to the problems of agriculture. Description analysis and appraisal of current policies and programs will be emphasized. (Beal)

AREC 444. WORLD AGRICULTURAL PRODUCTION AND TRADE (3)
World production, consumption, and trade patterns for agricultural products. International trade theory applied to agricultural products. National influences on international agricultural trade.

AREC 445. FOREIGN AGRICULTURAL ECONOMIES (3)
Analysis of the agricultural economy of selected areas of the world. The interrelationships among institutions and values, such as government and religion, and the economics of agricultural organization and production. (Holmes)

AREC 452. ECONOMICS OF RESOURCE DEVELOPMENT (3)
Economic, political, and institutional factors which influence the use of land resources. Application of elementary economic principles in understanding social conduct concerning the development and use of natural and man-made resources. (Tuthill)

AREC 453. ECONOMIC ANALYSIS OF NATURAL RESOURCES (3)
Rational use and reuse of natural resources. Theory and methodology of the allocation of natural resources among alternative uses. Optimum state of conservation, market failure, safe minimum standard and cost-benefit analysis. (Marasco)

AREC 484. INTRODUCTION TO ECONOMETRICS IN AGRICULTURE (3)
An introduction to the application of econometric techniques to agricultural problems with emphasis on the assumptions and computational techniques necessary to derive statistical estimates, test hypotheses, and make predictions with the use of single equation models. Includes linear and non-linear regression models, internal least squares, discriminant analysis and factor analysis. (Ishee)

AREC 485. APPLICATIONS OF MATHEMATICAL PROGRAMMING IN AGRICULTURE, BUSINESS, AND ECONOMIC ANALYSIS (3)
This course is designed to train students in the application of mathematical programming (especially linear programming) to solve a wide variety of problems in agriculture, business and economics. The primary emphasis is on setting up problems and interpreting results. The computational facilities of the computer science center are used extensively. (Bender)

AREC 495. HONORS READING COURSE IN AGRICULTURAL AND RESOURCE ECONOMICS I (3)
Selected readings in political and economic theory from 1700 to 1850. This course develops a basic understanding of the development of economic and political thought as a foundation for understanding our present society and its cultural heritage. Prerequisite, acceptance in the honors program of the department of agricultural economics.

AREC 496. HONORS READING COURSE IN AGRICULTURAL AND RESOURCE ECONOMICS II (3)
Selected readings in political and economic theory from 1850 to the present. This course continues the development of a basic understanding of economic and political thought begun in AREC 495. This understanding on the part of the student is further developed and broadened in this semester by the examination of modern problems in agricultural economics in the light of the material read and discussed in AREC 495 and AREC 496. Prerequisite: successful completion of AREC 495 and registration in the honors program of the department of Agricultural Economics.

AREC 639. INTERNSHIP IN RESOURCE MANAGEMENT (2-4)
Prerequisite, permission of major advisor and department chairman. Open only to graduate students in the AREC resource management curriculum. Repeatable to a maximum of four credit hours.

AREC 689. SPECIAL TOPICS IN AGRICULTURAL AND RESOURCE ECONOMICS (3)
Subject matter taught will be varied and will depend on the persons available for teaching unique and specialized phases of agricultural economics. The course will be taught by the staff or visiting agricultural economists who may be secured on lectureship or visiting professor basis.

AREC 698. SEMINAR (1)
Students will participate through study of problems in the field, reporting to seminar members and defending positions adopted. Outstanding leaders in the field will present ideas for analysis and discussion among class members. Students involved in original research will present progress reports. Class discussion will provide opportunity for constructive criticism and guidance. (Curtis)

AREC 699. SPECIAL PROBLEMS IN AGRICULTURAL AND RESOURCE ECONOMICS (1-2)
Intensive study and analysis of specific problems in the field of agricultural economics, which provide information in depth in areas of special interest to the student.

AREC 799. MASTER'S THESIS RESEARCH (1-6)
AREC 804. ADVANCED AGRICULTURAL PRICE AND DEMAND ANALYSIS (3)
An advanced study in the theory of: (1) the individual consumer, (2) household behavior, and (3) aggregate demand. The concepts of price and cross elasticities of demand, income elasticity of demand, and elasticity of substitution will be examined in detail. The use of demand theory in the analysis of welfare problems, market equilibrium (with special emphasis on trade) and the problem of insufficient and excessive aggregate demand will be discussed. (Marasco)

AREC 806. ECONOMICS OF AGRICULTURAL PRODUCTION (3)
Study of the more complex problems involved in the long-range adjustments, organization and operation of farm resources, including the impact of new technology and methods. Applications of the theory of the firm, linear programming, activity analysis and input-output analysis. (Hardie)

AREC 814. ADVANCED AGRI-BUSINESS MANAGEMENT (3)
Prerequisite, ECON 403, AREC 414, or permission of instructor. The application of advanced theories of management to agricultural business situations within the context of practical economic analysis. Relevant analytical techniques are utilized in a variety of problems and case study situations. (Cain)

AREC 824. ADVANCED AGRICULTURAL MARKETING (3)
Advanced study of the complex theoretical, institutional and legal factors governing both domestic and foreign agricultural trade, with particular attention given to policies and practices affecting cost and price. (Moore)

AREC 832. AGRICULTURAL PRICE AND INCOME POLICY (3)
The evolution of agricultural policy in the United States, emphasizing the origin and development of governmental programs, and their effects upon agricultural production, prices and income. (Beal)

AREC 844. ADVANCED THEORY AND PRACTICE OF INTERNATIONAL AGRICULTURAL TRADE (3)
Advanced theory, policies, and practices in international trade in agricultural products. Includes principal theories of trade and finance, agricultural trade policies of various countries, and the mechanics of trade. (Moore)

AREC 845. AGRICULTURE IN WORLD ECONOMIC DEVELOPMENT (3)
Theories and concepts of what makes economic development happen. Approaches and programs for stimulating the transformation from a primitive agricultural economy to an economy of rapidly developing commercial agriculture and industry. Analysis of selected agricultural development programs in Asia, Africa and Latin America. (Foster)

AREC 852. ADVANCED RESOURCE ECONOMICS (3)
Assessment and evaluation of our natural, capital, and human resources; the use of economic theory and various techniques to guide the allocation of these resources within a comprehensive framework; and the institutional arrangements for using these resources. ECON 403 or equivalent is a prerequisite. (Holmes)

AREC 883. AGRICULTURAL AND RESOURCE ECONOMICS RESEARCH TECHNIQUES (3)
Emphasis is given to philosophy and basic objectives of research in the field of agricultural economics. The course is designed to help students define a research problem and work out logical procedures for executing research in the social sciences. Attention is given to the techniques and tools available to agricultural economists. Research documents in the field will be appraised from the standpoint of procedures and evaluation of the research.

AREC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

AGRICULTURE COURSES

AGRI 401. AGRICULTURAL BIOMETRICS (3)
Two lectures and one laboratory period per week. Prerequisite, MATH 115 or equivalent. Probability, measures of central tendency and dispersion, frequency distributions, tests of statistical hypotheses, regression analysis, multiway analysis with emphasis on the use of statistical methods in agricultural research.

AGRI 489. SPECIAL TOPICS IN AGRICULTURE (1-3)
Credit according to time scheduled and organization of the course. A lecture series organized to study in depth a selected phase of agriculture not normally associated with one of the existing programs.

AGRI 601. DESIGN OF EXPERIMENTS (3)
Two lectures and one laboratory period per week. Prerequisite, AGRI 602 or its equivalent. The application of the principles of experimental design including basic and advanced designs, confounding, fractional replication and relative efficiencies.

AGRI 602. ADVANCED AGRICULTURAL BIOMETRICS (3)
Two lectures and one laboratory period per week. Prerequisite, AGRI 401 or equivalent. Analysis of variance to include factorials and split-plot design, analysis of covariance, multiple and curvilinear regression, enumeration data, non-parametric procedures and sample survey methods.

AGRI 604. STATISTICAL METHODS IN BIOLOGICAL ASSAY (3)
Prerequisite, AGRI 602 or its equivalent. The course

is intended to provide the graduate student with a working knowledge of statistical methods used in clude direct assays, quantitative dose-response relationships, parallel lines assays, assays based on quantal response, transformations and designs used in bioassay, and fine particle statistics.

AGRI 607. APPLICATION OF LEAST SQUARES METHODS (3)
Three lectures per week. Prerequisite, AGRI 602 or equivalent. Application of the method of least squares to the analysis of experimental data. Principles of the least squares method, basic matrix algebra, and the application of the least squares method of one-way and multi-way analysis of variants, analysis of covariants, and various component analysis will be considered. Emphasis given to the use use of least squares procedures for the analysis of data with unequal subclass numbers.

AGRI 702. EXPERIMENTAL PROCEDURES IN THE AGRICULTURAL SCIENCES (3)
Prerequisite, permission of instructor. Organization of research projects and presentation of experimental results in the field of agricultural science. Topics included will be: sources of research financing, project outline preparation, formal progress reports, public and industrial supported research programs, and popular presentation of research data.

AGRONOMY PROGRAM

Professor and Chairman: Miller
Professors: Axley, Clark, Decker, Foss, Strickling
Associate Professors: Aycock, Bandel, Caldwell (visiting), Fanning, Foss, Parochetti, Schillinger
Assistant Professors: Burt, Hall, Mulchi, Shannon

The Department of Agronomy offers graduate courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The student may pursue major work in the crops division or in the soils division of the department.

Thesis and non-thesis options are available for the Master of Science degree. Departmental regulations have been assembled for the guidance of candidates for graduate degrees. Copies of these regulations are available from the Department of Agronomy.

Ample laboratory and greenhouse facilities for graduate work are available on the campus. The Plant Research Farm, the Forage Research Farm, and the Tobacco Experiment Farm offer nearby research facilities. Many projects of the department are conducted in cooperation with the Agricultural Research Service of the United States Department of Agriculture with headquarters located three miles from the campus.

AGRO 403. CROP BREEDING (3)
Prerequisite, BOTN 414 or ZOOL 246. Principles and methods of breeding annual self and cross-pollinated plant and perennial forage species. (Schillinger)

AGRO 404. TOBACCO PRODUCTION (3)
Prerequisite, BOTN 100. A study of the history, adaptation, distribution, culture, and improvement of various types of tobacco, with special emphasis on problems in Maryland tobacco production. Physical and chemical factors associated with yield and quality of tobacco will be stressed. (Hoyert)

AGRO 405. TURF MANAGEMENT (3)
Two lectures and one laboratory period per week. Prerequisite, BOTN 100. A study of principles and practices of managing turf for lawns, golf courses, athletic fields, playgrounds, airfields and highways for commercial sod production. (Hall)

AGRO 406. FORAGE CROP PRODUCTION (2)
Prerequisite, BOTN 100, AGRO 100 or concurrent enrollment therein. Study of the production and management of grasses and legumes for quality hay, silage, and pasture. (Decker)

AGRO 407. CEREAL CROP PRODUCTION (2)
Prerequisite, BOTN 100, AGRO 100 or concurrent enrollment therein. Study of the principles and practices of corn, wheat, oats, barley, rye, and soybean production. (Shannon)

AGRO 411. SOIL FERTILITY PRINCIPLES (3)
Prerequisite, AGRO 202. A study of the chemical, physical, and biological characteristics of soils that are important in growing crops. Soil deficiencies of physical, chemical, or biological nature and their correction by the use of lime, fertilizers, and rotations are discussed and illustrated. (Strickling)

AGRO 412 COMMERCIAL FERTILIZERS (3)
Prerequisite, AGRO 202 or permission of instructor. A study of the manufacturing of commercial fertilizers and their use in soils for efficient crop production. (Axley)

AGRO 413. SOIL AND WATER CONSERVATION (3)
Two lectures and one laboratory period a week. Prerequisite, AGRO 202 or permission of instructor. A study of the importance and causes of soil erosion, methods of soil erosion control, and the effect of conservation practices on soil-moisture supply. Special emphasis is placed on farm planning for soil and water conservation. The laboratory period will be largely devoted to field trips. (Foss)

AGRO 414. SOIL CLASSIFICATION AND GEOGRAPHY (4)
Three lectures and one laboratory period a week. Prerequisite, AGRO 202 or permission of instructor. A study of the genesis, morphology, classification and geographic distribution of soils. The broad principles governing soil formation are explained. Attention is given to the influence of geographic factors on the development and use of the soils in the United States and other parts of the world. The laboratory periods will be largely devoted to the field trips and to a study of soil maps of various countries. (Fanning)

AGRO 415. SOIL SURVEY AND LAND USE (3)
Two lectures and one laboratory period a week. An introduction to soil survey interpretation as a tool in land use both in agricultural and urban situations. The implications of soil problems as delineated by soil surveys on land use will be considered. (F. Miller)

AGRO 417. SOIL PHYSICS (3)
Two lectures and one laboratory period a week. Prerequisite, AGRO 202 and a course in Physics, or per-

mission of instructor. A study of physical properties of soils with special emphasis on relationship to soil productivity. (Strickling)

AGRO 421. SOIL CHEMISTRY (3)
One lecture and two laboratory periods a week. Prerequisite, AGRO 202 or permission of instructor. A study of the chemical composition of soils; cation and anion exchange; acid, alkaline and saline soil conditions; and soil fixation of plant nutrients. Chemical methods of soil analysis will be studied with emphasis on their relation to fertilizer requirements. (Axley)

AGRO 422. SOIL BIOCHEMISTRY (3)
Two lectures and one laboratory period a week. Prerequisite, AGRO 202, CHEM 104 or consent of instructor. A study of biochemical processes involved in the formation and decomposition of organic soil constituents. Significance of soil-biochemical processes involved in plant nutrition will be considered.

AGRO 423. SOIL-WATER POLLUTION (3)
Prerequisite, background in biology and CHEM 104. Reaction and fate of pesticides, agricultural fertilizers, industrial and animal wastes in soil and water will be discussed. Their relation to the environment will be emphasized.

AGRO 451. CROPPING SYSTEMS (2)
Prerequisite, AGRO 102 or equivalent. The coordination of information from various courses in the development of balanced cropping systems, appropriate to different objectives in various areas of the State and Nation. (Clark)

AGRO 452. SEED PRODUCTION AND DISTRIBUTION (2)
One lecture and one laboratory period a week. Prerequisite, AGRO 102 or equivalent. A study of seed production, processing, and distribution. A study of seed production, processing, and distribution; Federal and State seed control programs; seed laboratory analysis; release of new varieties, and maintenance of foundation seed stocks. (Newcomer)

AGRO 453. WEED CONTROL (3)
Two lectures and one laboratory period a week. Prerequisite, AGRO 102 or equivalent. A study of the use of cultural practices and chemical herbicides in the control of weeds. (Burt)

AGRO 499. SPECIAL PROBLEMS IN AGRONOMY (1-3)
Prerequisites AGRO 202, 406, 407 or permission of instructor. A detailed study, including a written report of an important problem in Agronomy.

AGRO 601. ADVANCED CROP BREEDING (2)
Prerequisite, AGRO 403 or equivalent. Genetic, cytogenetic, and statistical theories underlying methods of plant breeding. A study of quantitative inheritance, herterosis, heritability, interspecific and intergeneric hybridization, polyploidy, sterility mechanisms, inbreeding and outbreeding, and other topics as related to plant breeding. (Schillinger)

AGRO 602. ADVANCED CROP BREEDING (2)
Prerequisite, AGRO 601 or equivalent. Genetic, cytogenetic, and statistical theories underlying methods of plant breeding. A study of quantitative inheritance, herterosis, heritability, interspecific and intergeneric hybridization, polyploidy, sterility mechanisms, inbreeding and outbreeding, and other topics as related to plant breeding. (Aycock)

AGRO 608. RESEARCH METHODS (2)
Prerequisite, permission of staff. Development of research viewpoint by detailed study and report on crop research of the Maryland Experiment Station or review of literature on specific phases of a problem.

AGRO 722. ADVANCED SOIL CHEMISTRY (3)
One lecture and two laboratory periods a week. Prerequisites, AGRO 202 and permission of instructor. A continuation of AGRO 421 with emphasis on soil chemistry or minor elements necessary for plant growth. (Axley)

AGRO 789. RECENT ADVANCES IN AGRONOMY (2-4)
Two hours each year. Total credit four hours. Prerequisite, permission of instructor. A study of recent advances in agronomy research.

AGRO 798. AGRONOMY SEMINAR (1)
Total credit toward Master of Science degree, 2; toward Ph.D. degree, 6. Prerequisite, permission of instructor.

AGRO 799. MASTER'S THESIS RESEARCH (1-6)

AGRO 802. BREEDING FOR RESISTANCE TO PLANT PESTS (3)
Prerequisites, ENTM 252, BOTN 221, AGRO 403, or permission of instructor. A study of the development of breeding techniques for selecting and utilizing resistance to insects and diseases in crop plants and the effect of resistance on the interrelationships of host and pest. (Schillinger, Shannon)

AGRO 804. TECHNIQUE IN FIELD CROP RESEARCH (2)
Prerequisites, field plot technique, application of statistical analysis to agronomic data, and preparation of the research project.

AGRO 805. ADVANCED TOBACCO PRODUCTION (2)
Prerequisite, permission of instructor. A study of the structural adaptation and chemical response of tobacco to environmental variations. Emphasis will be placed on the alkaloids and other unique components. (Hoyert)

AGRO 806. HERBICIDE CHEMISTRY AND PHYSIOLOGY (2)
Prerequisite, AGRO 453 and CHEM 104 or permission of instructor. Two lectures a week. The importance of chemical structure in relation to biologically significant reactions will be emphasized in more than 10 different herbicide groups. Recent advances in herbicidal metabolism, translocation, and mode of action will be reviewed. Adsorption, decomposition and movement in the soil will also be studied. (Burt)

AGRO 807. ADVANCED FORAGE CROPS (2)
Prerequisite, BOTN 441 or equivalent, or permission of instructor. A fundamental study of physiological and ecological responses of grasses and legumes to environmental factors, including fertilizer elements, soil moisture, soil temperature, humidity, length of

day, quality and intensity of light, wind movement, and defoliation practices. Relationship of these factors to life history, production, chemical and botanical composition, quality, and persistence of forages will be considered. (Decker)

AGRO 821. ADVANCED METHODS OF SOIL INVESTIGATION (3)
Prerequisites, AGRO 202 and permission of instructor. An advanced study of the theory of the chemical methods of soil investigation with emphasis on problems involving application of physical chemistry. (Axley)

AGRO 831. ADVANCED SOIL MINERALOGY (3)
Prerequisites, AGRO 202 and permission of instructor. A study of the structure, physical-chemical characteristics and identification methods of soil minerals, particularly clay minerals, and their relationship to soil genesis and productivity. (Fanning)

AGRO 832. ADVANCED SOIL PHYSICS (3)
Prerequisites, AGRO 202 and permission of instructor. An advanced study of physical properties of soils. (Strickling)

AGRO 899. DOCTORAL DISSERTATION RESEARCH (1-8)

AMERICAN STUDIES PROGRAM

Professor and Director: Beall
Associate Professor: Lounsbury
Assistant Professor: Mintz

The Program in American Studies offers work leading to the M.A. (thesis or non-thesis option) and Ph.D. degrees. It requires a concentration in either American history or literature and permits work in the supporting fields of American studies, literature or history; behavioral and social sciences; American art and material culture; American thought; Afro-American studies; urban and environmental studies; popular culture; and comparative culture.

Admission requirements include strong backgrounds in American studies, history, literature, the humanities.

The Program in American Studies collaborates with the Smithsonian Institution's Department of American Studies.

AMST 426. CULTURE AND THE ARTS IN AMERICA (3)
A study of American institutions, the intellectual and esthetic climate from the Colonial Period to the present. (Lounsbury)

AMST 427. CULTURE AND THE ARTS IN AMERICA (3)
A study of American institutions, the intellectual and esthetic climiate from the Colonial Period to the present. (Lounsbury)

AMST 436. READINGS IN AMERICAN STUDIES (3)
An historical survey of American values as presented in various key writings. (Mintz)

AMST 437. READINGS IN AMERICAN STUDIES (3)
An historical survey of American values as presented in various key writings. (Mintz)

AMST 446. POPULAR CULTURE IN AMERICA (3)
Prerequisite, permission of instructor. A survey of the historical development of the popular arts and modes of popular entertainment in America. (Mintz)

AMST 447. POPULAR CULTURE IN AMERICA (3)
Prerequisite, AMST 446. Intensive research in the sources and themes of contemporary American popular culture. (Mintz)

AMST 618. INTRODUCTORY SEMINAR IN AMERICAN STUDIES (3) (Beall, Lounsbury)

AMST 628. SEMINAR IN AMERICAN STUDIES (3) (Beall, Lounsbury, Mintz)

AMST 629. SEMINAR IN AMERICAN STUDIES (3) (Beall, Lounsbury, Mintz)

AMST 638. ORIENTATION SEMINAR—MATERIAL ASPECTS OF AMERICAN CIVILIZATION (3)
Class meets at the Smithsonian.

AMST 639. READING COURSE IN SELECTED ASPECTS OF AMERICAN CIVILIZATION (3)
Class meets at the Smithsonian.

AMST 799. MASTER'S THESIS RESEARCH (1-6)
AMST 899. DOCTORAL DISSERTATION RESEARCH (1-8)

ANIMAL SCIENCE PROGRAM

Professor and Chairman: Young
Professors: Green, Leffel
Associate Professors: Buric, DeBarthe
Assistant Professor: McCall

The Department of Animal Science offers work leading to the degrees of Master of Science and Doctor of Philosophy. Course work and thesis problems are offered in the areas of animal breeding, nutrition, physiology, and livestock production.

Individual programs can be oriented toward either basic research or the solution of problems in the applied areas. Beef cattle, horses, sheep, swine and laboratory animals are available for graduate student problems.

Departmental requirements have been formulated for the information and guidance of graduate students. Copies of these requirements are available from the Department of Animal Science.

ANSC 401. FUNDAMENTALS OF NUTRITION (3)
Three lectures per week. Prerequisite, CHEM 104; ANSC 212 recommended. A study of the fundamental role of all nutrients in the body including their digestion, absorption and metabolism. Dietary requirements and nutritional deficiency syndromes of laboratory and farm animals and man will be considered. (Soares)

ANSC 402. APPLIED ANIMAL NUTRITION (3)
Two lectures and one laboratory period per week. Prerequisites, MATH 110, ANSC 401 or permission of instructor. A critical study of those factors which influence the nutritional requirements of ruminants, swine and poultry. Practical feeding methods and procedures used in formulation of economically efficient rations will be presented. (Vandersall)

ANSC 406. ANIMAL ADAPTATIONS TO THE ENVIRONMENT (3)
Three lectures per week. Prerequisites, anatomy and physiology or concurrent registration in physiology. The specific anatomical and physiological modifications employed by animals adapted to certain stressful environments will be considered. Particular emphasis will be placed on the problems of temperature regulation and water balance. Specific areas for consideration will include: animals in cold (including hibernation), animals in dry heat, diving animals and animals in high altitudes. (Albert)

ANSC 407. ADVANCED DAIRY PRODUCTION (1)
Summer session only. An advanced course primarily designed for teachers of vocational agriculture and county agents. It includes a study of the newer discoveries in dairy cattle nutrition, breeding and management.

ANSC 411. BIOLOGY AND MANAGEMENT OF SHELLFISH (4)
Two lectures and two 3-hour laboratory periods each week. Field trips. Identification, biology, management, and culture of commercially important molluscs and crustacea. Prerequisite, one year of biology or zoology. This course will examine the shellfisheries of the world, but will emphasize those of the northwestern Atlantic Ocean and Chesapeake Bay. (Anderson)

ANSC 412. INTRODUCTION TO DISEASES OF ANIMALS (3)
Prerequisite, MICB 200 and ZOOL 101. Two lectures and one laboratory period per week. This course gives basic instruction in the nature of disease: including causation, immunity, methods of diagnosis, economic importance, public health aspects and prevention and control of the common diseases of sheep, cattle, swine, horses and poultry. (Albert)

ANSC 413. LABORATORY ANIMAL MANAGEMENT (3)
A comprehensive course in care and management of laboratory animals. Emphasis will be placed on physiology, anatomy and special uses for the different species. Disease prevention and regulations for maintaining animal colonies will be covered. Field trips will be required. (Marquardt)

ANSC 414. BIOLOGY AND MANAGEMENT OF FISH (4)
Prerequisite, one year of biology or zoology. Two lectures and two 3-hour laboratories a week. Fundamentals of individual and population dynamics: theory and practice of sampling fish populations; management schemes. (Anderson)

ANSC 416. WILDLIFE MANAGEMENT (3)
Two lectures and one laboratory. An introduction to the interrelationships of game birds and mammals with their environment, population dynamics and the principles of wildlife management.

ANSC 422. MEATS (3)
Two lectures and one laboratory period per week. Prerequisite, ANSC 221. A course designed to give the basic facts about meat as a food and the factors influencing acceptability, marketing, and quality of fresh meats. It includes comparisons of characteristics of live animals with their carcasses, grading and evaluating carcasses as well as wholesale cuts, and the distribution and merchandising of the nation's meat supply. Laboratory periods are conducted in packing houses, meat distribution centers, retail outlets and university meats laboratory. (Buric)

ANSC 423. LIVESTOCK MANAGEMENT (3)
One lecture and two laboratory periods per week. Prerequisite, ANSC 401. Application of various phases of animal science to the management and production of beef cattle, sheep and swine. (DeBarthe)

ANSC 424. LIVESTOCK MANAGEMENT (3)
One lecture and two laboratory periods per week. Prerequisite, ANSC 423. Application of various phases of animal science to the management and production of beef cattle, sheep and swine. (Leffel)

ANSC 426. PRINCIPLES OF BREEDING (3)
Three lectures per week. Prerequisites, ANSC 201 or equivalent, ANSC 222, ANSC 423 or 424. Graduate credit (1-3 hours) allowed with permission of instructor. The practical aspects of animal breeding, heredity, variation, selection, development, systems of breeding and pedigree study are considered. (Green)

ANSC 442. DAIRY CATTLE BREEDING (3)
Two lectures and one laboratory period per week. Prerequisites, ANSC 242, and ANSC 201. A specialized course in breeding dairy cattle. Emphasis is placed on methods of evaluation and selection, systems of breeding and breeding programs. (Douglas)

ANSC 444. ANALYSIS OF DAIRY PRODUCTION SYSTEMS (3)
Prerequisites, AGEC 406 and ANSC 203 or 402, or permission of instructor. The business aspects of dairy farming including an evaluation of the costs and returns associated with each segment. The economic impact of pertinent management decisions is studied. Recent developments in animal nutrition and genetics, agricultural economics, agricultural engineering, and agronomic practices are discussed as they apply to management of a dairy herd. (Buchman)

ANSC 446. PHYSIOLOGY OF MAMMALIAN REPRODUCTION (3)
Two lectures and one 3-hour laboratory period per week. Prerequisite, ZOOL 422 or ANSC 212. Anatomy and physiology of reproductive processes in wild and domesticated mammals. (Williams)

ANSC 452. AVIAN PHYSIOLOGY (2)
Alternate even years. One 3-hour laboratory period per week. Prerequisites, a basic course in animal physiology. The basic physiology of the bird is discussed, excluding the reproductive system. Special emphasis is given to physiological differences between birds and other vertebrates. (Pollard)

ANSC 462. PHYSIOLOGY OF HATCHABILITY (1)
One 3-hour laboratory period per week. Prerequisite, ZOOL 421 or 422. The physiology of embryonic development as related to principles of hatchability and problems of incubation encountered in the hatchery industry are discussed. (Shafner)

ANSC 464. POULTRY HYGIENE (3)
Two lectures and one laboratory period per week. Prerequisites, MICB 200 and ANSC 101. Virus, bacterial and protozoan diseases, parasitic diseases, prevention, control and eradication. (Marquardt)

ANSC 466. AVIAN ANATOMY (3)
Two lectures and one laboratory per week. Prerequisite, ZOOL 102. Gross and microscopic structure, dissection and demonstration. (Marquardt)

ANSC 467. POULTRY BREEDING AND FEEDING (1)
Summer session only. This course is designed primarily for teachers of vocational agriculture and extension service workers. The first half will be devoted to problems concerning breeding and the development of breeding stock. The second half will be devoted to nutrition.

ANSC 477. POULTRY PRODUCTS AND MARKETING (7)
Summer session only. This course is designed primarily for teachers of vocational agriculture and county agents. It deals with the factors affecting the quality of poultry products and with hatchery management problems, egg and poultry grading, preservation problems and market outlets for Maryland poultry.

ANSC 480. SPECIAL TOPICS IN FISH AND WILDLIFE MANAGEMENT (3)
Three lectures. Analysis of various state and federal programs related to fish and wildlife management. This would include: fish stocking programs, Maryland deer management program, warm water fish management, acid drainage problems, water quality, water fowl management, wild turkey management and regulations relative to the administration of these programs.

ANSC 487. SPECIAL TOPICS IN ANIMAL SCIENCE (1)
Prerequisite, permission of instructor. Summer session only. This course is designed primarily for teachers of vocational agriculture and extension service personnel. One primary topic to be selected mutually by the instructor and students will be presented each session.

ANSC 601. ADVANCED RUMINANT NUTRITION (2)
One 1-hour lecture and one 3-hour laboratory per week. Prerequisite, permission of instructor. Physiological, microbiological and biochemical aspects of the nutrition of ruminants as compared to other animals. (Vandersall)

ANSC 603. MINERAL METABOLISM (3)
Three lectures per week. Prerequisites, CHEM 481 and 463. The role of minerals in metabolism of animals and man. Topics to be covered include the role of minerals in energy metabolism, bone structure, electrolyte balance, and as catalysts. (Bull)

ANSC 604. VITAMINS (2)
One lecture and one laboratory per week. Prerequisites, ANSC 401 and CHEM 461. Advanced study of the fundamental role of vitamins in nutrition including chemical properties, absorption, metabolism, storage, excretion and deficiency syndromes. A critical study of the biochemical basis of vitamin function, interrelationships of vitamins with other substances and of certain laboratory techniques. (Soares)

ANSC 610. ELECTRON MICROSCOPY (4)
Two lectures and two laboratory periods per week. Prerequisites, permission of instructor. Theory of electron microscopy, electron optics, specimen preparation and techniques, operation of electron photography, interpretation of electron images, related instruments and techniques. (Dutta, Mohanty)

ANSC 622. ADVANCED BREEDING (2)
Two lectures a week. Prerequisites, ANSC 426 or equivalent, and biological statistics. This course deals with the more technical phases of heredity and variation, selection indices, breeding systems, and inheritance in farm animals. (Green)

ANSC 641. EXPERIMENTAL MAMMALIAN SURGERY I (2)
Prerequisite, permission of instructor. A course presenting the fundamentals of anesthesia and the art of experimental surgery, especially to obtain research preparations.

ANSC 642. EXPERIMENTAL MAMMALIAN SURGERY II (3)
Prerequisites, ANSC 641, permission of instructor. A course emphasizing advanced surgical practices to obtain research preparations, cardiovascular surgery and chronic vascularly isolated organ techniques. Experience with pump oxygenator systems, profound hypothermia, hemodialysis, infusion systems, implantation and transplantation procedures is taught.

ANSC 643. RESEARCH METHODS (3)
One lecture and two laboratory periods per week. Prerequisite, permission of instructor. The application of biochemical, physio-chemical and statistical methods to problems in biological research.

ANSC 660. POULTRY LITERATURE (1-4)
Readings on individual topics are assigned. Written reports required. Methods of analysis and presentation of scientific material are discussed. (Thomas)

ANSC 661. PHYSIOLOGY OF REPRODUCTION (3)
Two lectures and one laboratory period a week. Prerequisite, ANSC 212 or its equivalent. The role of the endocrines in reproduction is considered. Fertility, sexual maturity, egg formation, ovulation, and the physiology of oviposition are studied. Comparative processes in birds and mammals are discussed. (Shafner)

ANSC 665. PHYSIOLOGICAL GENETICS OF DOMESTIC ANIMALS (2)
Two lectures per week. Prerequisites, a course in basic genetics and biochemistry. The underlying physiological basis for genetic differences in production traits and selected morphological traits will be discussed. Inheritance of enzymes, protein polymorphisms and physiological traits will be studied. (Pollard)

ANSC 677. ADVANCED ANIMAL ADAPTATIONS TO THE ENVIRONMENT (2)
Two lectures or discussions per week. Prerequisites, ANSC 406, or permission of instructor. A detailed

consideration of certain anatomical and physiological modifications employed by mammals adapted to cold, dry heat or altitude. Each student will submit for discussion a library paper concerning a specific adaptation to an environmental stress.

ANSC 690. SEMINAR IN POPULATION GENETICS OF DOMESTIC ANIMALS (3)
Prerequisites, ZOOL 246 and AGRI 401 or their equivalents. Current literature and research dealing with the principles of population genetics as they apply to breeding and selection programs for the genetic improvement of domestic animals, population structure, estimation of genetic parameters, correlated characters, principles and methods of selection, relationship and systems of mating. (Douglas)

ANSC 698. SEMINAR (1)
Students are required to prepare papers based upon current scientific publications relating to animal science, or upon their research work, for presentation before and discussion by the class: (1) recent advances; (2) nutrition; (3) physiology; (4) biochemistry.

ANSC 699. SPECIAL PROBLEMS IN ANIMAL SCIENCE (1-2)
Work assigned in proportion to amount of credit. Prerequisite, approval of staff. Problems will be assigned which relate specifically to the character of work the student is pursuing.

ANSC 799. MASTER'S THESIS RESEARCH (1-6)

ANSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

ANTHROPOLOGY COURSES

ANTH 401. CULTURAL ANTHROPOLOGY—PRINCIPLES AND PROCESSES (3)
Prerequisite, ANTH 101, 102, or 221. An examination of the nature of human culture and its processes, both historical and functional. The approach will be topical and theoretical rather than descriptive.
(Anderson, Dessaint, Hoffman, Williams)

ANTH 402. CULTURAL ANTHROPOLOGY—WORLD ETHNOGRAPHY (3)
Prerequisite, ANTH 101, 102, or 221. A descriptive survey of the culture areas of the world through an examination of the ways of selected representative societies. (Anderson, Dessaint, Hoffman, Williams)

ANTH 412. PEOPLES AND CULTURES OF OCEANIA (3)
A survey of the cultures of Polynesia, Micronesia, Melanesia and Australia. Theoretical and cultural-historical problems will be emphasized.
(Anderson, Dessaint)

ANTH 414. ETHNOLOGY OF AFRICA (3)
Prerequisites, ANTH 101 and 102. The native peoples and cultures of Africa and their historical relationships, with emphasis on that portion of the continent south of the Sahara.

ANTH 417. PEOPLES AND CULTURES OF THE FAR EAST (3)
A survey of the major sociopolitical systems of China, Korea and Japan. Major anthropological questions will be dealt with in presenting this material.
(Dessaint)

ANTH 423. ETHNOLOGY OF THE SOUTHWEST (3)
Prerequisites, ANTH 101 and 102. Culture history, economic and social institutions, religion, and mythology of the Indians of the Southwest United States. (Anderson, Williams)

ANTH 424. ETHNOLOGY OF NORTH AMERICA (3)
Prerequisites, ANTH 101 and 102. The native people and cultures of North America north of Mexico and their historical relationships, including the effects of contact with European-derived populations.
(Anderson, Hoffman, Thurman)

ANTH 426. ETHNOLOGY OF MIDDLE AMERICA (3)
Prerequisites, ANTH 101 and 102. Cultural background and modern social, economic and religious life of Indian and Mestizo groups in Mexico and Central America; processes of acculturation and currents in cultural development. (Williams)

ANTH 431. SOCIAL ORGANIZATION OF PRIMITIVE PEOPLES (3)
Prerequisites, ANTH 101 and 102. A comparative survey of the structures of non-literate and folk societies, covering both general principles and special regional developments.

ANTH 434. RELIGION OF PRIMITIVE PEOPLES (3)
Prerequisites, ANTH 101 and 102. A survey of the religious systems of primitive and folk societies, with emphasis on the relation of religion to other aspects of culture. (Anderson)

ANTH 436. PRIMITIVE TECHNOLOGY AND ECONOMY (3)
A survey of technology, food economy and general economic processes in non-industrial societies.
(Anderson)

ANTH 437. POLITICS AND GOVERNMENT IN PRIMITIVE SOCIETY (3)
A combined survey of politics in human societies and of important anthropological theories concerning this aspect of society. (Williams)

ANTH 441. ARCHAEOLOGY OF THE OLD WORLD (3)
Prerequisite, ANTH 101 or 241. A survey of the archaeological materials of Europe, Asia and Africa, with emphasis on chronological and regional interrelationships. (Schacht, Thurman)

ANTH 451. ARCHAEOLOGY OF THE NEW WORLD (3)
Prerequisite, ANTH 101 or 241. A survey of the archaeological materials of North and South America with emphasis on chronological and regional interrelationships. (Schacht, Thurman)

ANTH 461. ADVANCED PHYSICAL ANTHROPOLOGY (3)
Prerequisite, ANTH 101 or 261. A technical introduction to the hereditary, morphological, physiological, and behavioral characteristics of man and his primate ancestors and relatives, with emphasis on evolutionary processes. (Kerley, Rosen)

ANTH 498. FIELD METHODS IN ETHNOLOGY (1-6)
Field training in the collection and recording of ethnological data. (Summer only).
(Dessaint, Williams)

ANTH 499. FIELD METHODS IN ARCHAEOLOGY (1-6)
Field training in the techniques of archaeological survey and excavation. (Summer only).
(Schacht, Thurman)

ANTH 605. THEORY OF CULTURAL ANTHROPOLOGY (3)
History and current trends of cultural anthropological theory, as a basic orientation for graduate studies and research. (Dessiant, Hoffman, Williams)

ANTH 621. CULTURAL ECOLOGY (3)
Prerequisite, permission of instructor. An examination of the nature of the interrelationships between human cultures and the natural environment in which they exist. (Anderson, Thurman)

ANTH 631. EVOLUTION IN SOCIAL INSTITUTIONS (3)
An inquiry into the origin and development of institutions of kinship, marriage, and group formation in differing socio-cultural systems. (Williams)

ANTH 637. POLITICAL POWER AND ORGANIZATION (3)
A seminar concerning the nature of political power, distribution, and the way it allows different socio-cultural systems to solve major adaptive problems.
(Williams)

ANTH 641. METHOD AND THEORY IN ARCHAEOLOGY (3)
Prerequisite, permission of the instructor. An examination of the principles and purposes involved in the gathering and interpretation of archaeological data.
(Schacht, Thurman)

ANTH 661. HUMAN MORPHOLOGY (3)
Prerequisite, ANTH 461 or its equivalent and permission of the instructor. The nature and variation of human skeletal and somatic characters, with emphasis on evolutionary developments. (Kerley, Rosen)

ANTH 681. PROCESSES OF CULTURE CHANGE (3)
Change in culture due to contact, diffusion, innovation, fusion, integration, and cultural evolution.
(Hoffman, Dessaint, Williams)

ANTH 685. PEASANT COMMUNITIES IN THE MODERN WORLD (3)
Comparative analysis of peasant communities in Latin America, Europe, Middle East, Asia and Africa.
(Dessaint, Williams)

ANTH 688. CURRENT DEVELOPMENTS IN ANTHROPOLOGY (3)
Detailed investigation of a current problem or research technique, the topic to be chosen in accordance with faculty interests and student needs. May be repeated, as content varies, for a total of not more than nine semester hours.

ANTH 689. SPECIAL PROBLEMS IN ANTHROPOLOGY (1-6) (Staff)

ANTH 698. ADVANCED FIELD TRAINING IN ANTHROPOLOGY (1-6) (Staff)
Offered in the summer session only.
(Dessaint, Williams)

ANTH 699. ADVANCED FIELD TRAINING IN ARCHAEOLOGY (1-6)
Offered in the summer session only.
(Schacht, Thurman)

ARCHITECTURE COURSES

ARCH 413. STRUCTURAL SYSTEMS IN ARCHITECTURE (3)
Theory and application of selected complex structural systems as they relate to architectural decisions. Prerequisite, ARCH 410 or by permission of the instructor. Seminar, 3 hours per week.
(Schaeffer, Lazaris)

ARCH 420. HISTORY OF AMERICAN ARCHITECTURE (3)
Survey history of American architecture from the 17th Century to the present. Lecture, 3 hours per week. (Senkevitch)

ARCH 422. LATE 18TH CENTURY PARISIAN ARCHITECTURE (3)
The theoretical background, formulation, and development of the late Eighteenth Century architecture in Paris, and its relationship to contemporaneous British and Continental developments in architecture and Continental developments in architecture and peripheral fields. A reading knowledge of French will be required. Colloquium, independent research. By permission of the instructor. (Wiebenson)

ARCH 424. HISTORY OF RUSSIAN ARCHITECTURE (3)
Survey history of Russian architecture from the 10th Century to the present. Three hours per week.

ARCH 426. READINGS IN CONTEMPORARY ARCHITECTURE (3)
Prerequisite, ARCH 326. Readings and analysis of recent architectural criticism. Seminar, three hours per week. (Wiebenson)

ARCH 427. INDEPENDENT STUDIES IN THE HISTORY OF ARCHITECTURE (3)
Permission of the instructor. Independent research in architectural history. Lecture 3 hours per week.

ARCH 450. INTRODUCTION TO URBAN PLANNING (3)
Introduction to city planning theory, methodology and techniques, dealing with normative, urban, structural, economic, social aspects of the city; urban planning as a process. Architectural majors or by permission of the instructor. Lecture, seminar, 3 hours per week. (Skiadaressis)

ARCH 451. URBAN DESIGN SEMINAR (3)
Prerequisite, ARCH 350 or permission of the instructor. Advanced investigation into problems of analysis and evaluation of the design of urban areas, spaces and complexes with emphasis on physical and social considerations. Effects of public policies through case studies. Field observations.

ARCH 472. ECONOMIC DETERMINANTS OF ARCHITECTURE (3)
Introduction of economic aspects of present day architecture: government policy, land evaluation, and project financing; construction materials and labor

costs; cost analysis and control systems. Architecture majors, except by permission of instructor. Lecture, seminar, 3 hours per week. (Schlesinger)

ARCH 478. DIRECTED STUDIES IN ARCHITECTURE (1-4)
Directed study under individual faculty guidance with enrollment limited to advanced undergraduate students. Project proposals must receive a recommendation from the school curriculum committee and approval of the dean of the school prior to registration. Public oral presentation to the faculty of a final report of project will be required at final submission for credit.

ART PROGRAM

Professor and Chairman: Levitine
Professors: Bunts, deLeiris, Denny, Jamieson, Lembach, Lynch, Maril
Associate Professors: Campbell, DiFederico, Longley,[1] Pemberton, Rearick
Assistant Professors: Farquhar, Isen, Niese

[1] joint appointment with Secondary Education

The Department of Art offers programs of graduate study leading to the degrees of Master of Arts in art history, Master of Fine Arts in studio art and Doctor of Philosophy in art history. Both disciplines, rooted in the concept of art as a humanistic experience, share an essential common aim: the development of the student's aesthetic sensitivity, understanding and knowledge. The major in art history is committed to the advanced study and scholarly interpretation of existing works of art, from the prehistoric era to the present, while the studio major stresses the student's direct participation in the creation of works of art.

For admission to graduate study in studio art, an undergraduate degree with an art major from an accredited college or university, or its equivalent, is required. The candidate should have approximately 30 credit hours of undergraduate work in studio courses, and 12 credit hours in art history courses. Other humanities area courses should be part of the candidate's undergraduate preparation. In addition, special departmental requirements must be met. A candidate for the Masters degree will be required to pass an oral comprehensive examination, present an exhibition of his thesis work, and an oral defense of the thesis.

For admission to graduate study in art history, in addition to the approved undergraduate degree, or its equivalent, special departmental requirements must be met. Departmental requirements for the Master of Arts degree in Art History include ARTH 692; reading knowledge of French or German (evidenced by an examination administered by the Art Department); a written comprehensive examination which tests the candidate's knowledge and comprehension of principal areas and phases of art history; a thesis which demonstrates competency in research and in original investigation by the candidate; and a final oral examination on the thesis and the field which it represents.

Requirements for the Doctor of Philosophy degree in Art History include ARTH 692; reading knowledge of French *and* German; an oral examination and an intensive research problem; a dissertation which demonstrates the candidate's capacity to perform independent research in the field of art history; and a final oral examination on the dissertation and the field it represents.

For information on work leading the degree of Master of Education in art education, the student is referred to the section devoted to Secondary Education in this catalog.

A limited number of graduate assistantships are available in art. Specific information on the above programs should be requested from the department.

ART EDUCATION

ARTE 600. ADVANCED PROBLEMS IN ART EDUCATION (3)

ARTE 601. ADVANCED PROBLEMS IN ART EDUCATION (3)

ARTE 799. MASTER'S THESIS RESEARCH (1-6)

ART HISTORY

ARTH 402. CLASSICAL ART (3)
Architecture, sculpture and painting in the classical cultures. First semester will stress Greece.

ARTH 403. CLASSICAL ART (3)
Architecture, sculpture and painting in the classical cultures. Second semester will stress Rome.

ARTH 404. BRONZE AGE ART (3)
Art of the Near East, Egypt and Aegean.

ARTH 406. ART OF THE EAST (3)
Architecture, sculpture and painting. First semester will stress India.

ARTH 407. ART OF THE EAST (3)
Architecture, sculpture and painting. Second semester will stress China and Japan.

ARTH 410. EARLY CHRISTIAN AND BYZANTINE ART (3)
Architecture, sculpture, painting, and mosaic of early Christian Rome, the Near East and the Byzantine Empire.

ARTH 412. MEDIEVAL ART (3)
Architecture, sculpture and painting in the Middle Ages. First semester will stress Romanesque.

ARTH 413. MEDIEVAL ART (3)
Architecture, sculpture and painting in the Middle Ages. Second semester will stress the Gothic Period.

ARTH 416. NORTHERN EUROPEAN PAINTING IN THE 15TH CENTURY (3)
Painting in the Netherlands, France and Germany.

ARTH 417. NORTHERN EUROPEAN PAINTING IN THE 16TH CENTURY (3)
Painting in the Netherlands, France and Germany.

ARTH 422. EARLY RENAISSANCE ART IN ITALY (3)
Architecture, sculpture and painting from about 1400 to 1430.

ARTH 423. EARLY RENAISSANCE ART IN ITALY (3)
Architecture, sculpture and painting from about 1430 to 1475.

ARTH 424. HIGH RENAISSANCE ART IN ITALY (3)
Architecture, sculpture and painting from about 1475 to 1500.

ARTH 425. HIGH RENAISSANCE ART IN ITALY (3)
Architecture, sculpture and painting from about 1500 to 1525.

ARTH 430. EUROPEAN BAROQUE ART (3)
Architecture, sculpture and painting of the major Southern European centers in the 17th Century.

ARTH 431. EUROPEAN BAROQUE ART (3)
Architecture, sculpture and painting of the major Northern European centers in the 17th Century.

ARTH 434. FRENCH PAINTING (3)
French painting from 1400 to 1600. From Fouquet to Poussin.

ARTH 435. FRENCH PAINTING (3)
French painting from 1600 to 1800. From LeBrun to David.

ARTH 440. 19TH CENTURY EUROPEAN ART (3)
Architecture, sculpture and painting in Europe from Neo-Classicism to Romanticism.

ARTH 441. 19TH CENTURY EUROPEAN ART (3)
Architecture, sculpture and painting in Europe. From Realism, to Impressionism and Symbolism.

ARTH 445. IMPRESSIONISM AND NEO-IMPRESSIONISM (3)
Prerequisite, ARTH 260, 261 or consent of instructor. History of Impressionism and Neo-Impressionism: artists, styles, art theories, criticism, sources and influence on 20th Century.

ARTH 450. 20TH CENTURY ART (3)
Painting, sculpture and architecture from the late 19th Century to 1920.

ARTH 451. 20TH CENTURY ART (3)
Painting, sculpture and architecture from 1920 to the present.

ARTH 454. NINETEENTH AND TWENTIETH CENTURY SCULPTURE (3)
Trends in sculpture from Neo-Classicism to the present. Emphasis will be put on the redefinition of sculpture during the 20th Century.

ARTH 460. HISTORY OF THE GRAPHIC ARTS (3)
Prerequisite, ARTH 100, or ARTH 260 and 261, or consent of instructor. Graphic techniques and styles in Europe from 1400 to 1800; contributions of major artists.

ARTH 462. AFRICAN ART (3)
First semester, the cultures west of the Niger River (Nigeria through Mali) from 400 B.C. to the present. The art is studied through its iconography and function in the culture and the intercultural influences upon the artists, including a study of the societies, cults and ceremonies during which the art was used.

ARTH 463. AFRICAN ART (3)
Second semester, the cultures east and south of Nigeria. The art is studied through its iconography and function in the culture and the intercultural influences upon the artists, including a study of the societies, cults and ceremonies during which the art was used.

ARTH 464. AFRICAN ART RESEARCH (3)
Prerequisite, ARTH 462, 463 or departmental permission. Seminar type course with concentration on particular aspects of African art. The course is given at the Museum of African Art in Washington, D.C.

ARTH 470. LATIN AMERICAN ART (3)
Art of the Pre-Hispanic and the Colonial Periods.

ARTH 471. LATIN AMERICAN ART (3)
Art of the 19th and 20th Centuries.

ARTH 476. HISTORY OF AMERICAN ART (3)
Architecture, sculpture and painting in the United States from the Colonial Period to about 1875.

ARTH 477. HISTORY OF AMERICAN ART (3)
Architecture, sculpture and painting in the United States from about 1875 to the present.

ARTH 489. SPECIAL TOPICS IN ART HISTORY (3)
Prerequisite, consent of department head or instructor. May be repeated to a maximum of six credits.

ARTH 498. DIRECTED STUDIES IN ART HISTORY I (2-3)
For advanced students, by permission of department chairman. Course may be repeated for credit if content differs.

ARTH 499. DIRECTED STUDIES IN ART HISTORY II (2-3)

ARTH 612. ROMANESQUE ART (2-3)
Painting and sculpture in Western Europe in the 11th and 12th Centuries; regional styles; relationships between styles of painting and sculpture; religious content.

ARTH 614. GOTHIC ART (3)
Painting and sculpture in Western Europe in the 11th and 12th Centuries; regional styles; relationships between styles of painting and sculpture; religious content.

ARTH 630. THE ART OF MANNERISM (3)
Prerequisite, ART 423 or permission of instructor. Mannerism in Europe during the 16th Century; beginnings in Italy; ramifications in France, Germany, Flanders, Spain; painting, architecture, and sculpture.

ARTH 634. FRENCH PAINTING FROM LEBRUN TO GERICAULT, 1715-1815 (3)
Development of iconography and style from the Baroque to Neo-Classicism and Romanticism. Trends and major artists.

ARTH 656. 19TH CENTURY REALISM, 1830-1860 (3)
Prerequisite, ART 440 or 441 or equivalent. Courbet and the problem of realism; precursors, David, Gericault, Landscape Schools; Manet; artistic and social theories; realism outside France.

ARTH 662. 20TH CENTURY EUROPEAN ART (3)
Prerequisite, ART 450, 451 or equivalent. A detailed examination of the art of an individual country in the 12th Century: France, Germany, Italy, Spain, England.

ARTH 676. 20TH CENTURY AMERICAN ART (3)
Prerequisite, ART 450, 451 or equivalent. The "Eight," "the Armory Show," American Abstraction, Romantic-Realism, New Deal art projects, American Surrealism and Expressionism.

ARTH 692. METHODS OF ART HISTORY (3)
Methods of research and criticism applied to typical art-historical problems; bibliography and other research tools. May be taken for credit one or two semesters.

ARTH 694. MUSEUM TRAINING PROGRAM (3)

ARTH 695. MUSEUM TRAINING PROGRAM (3)

ARTH 698. DIRECTED GRADUATE STUDIES IN ART HISTORY (3)
For advanced graduate students, by permission of head of department. Course may be repeated for credit if content differs.

ARTH 699. SPECIAL TOPICS IN ART HISTORY (3)
Prerequisite, consent of department head or instructor.

ARTH 702. SEMINAR IN CLASSICAL ART (3)
Prerequisite, ARTH 402, 403 or permission of instructor.

ARTH 712. SEMINAR IN MEDIEVAL ART (3)
Prerequisite, ARTH 412, 413 or permission of instructor

ARTH 728. SEMINAR TOPICS IN ITALIAN RENAISSANCE ART (3)
Problems selected from significant themes in the field of Italian Renaissance art and architecture, 1200-1600. May be repeated for credit if content differs.

ARTH 736. SEMINAR IN 18TH CENTURY EUROPEAN ART (3)

ARTH 740. SEMINAR IN ROMANTICISM (3)
Problems derived from the development of Romantic Art during the 18th and 19th Centuries.

ARTH 743. SEMINAR IN 19TH CENTURY EUROPEAN ART (3)
Problems derived from the period starting with David and ending with Cezanne.

ARTH 760. SEMINAR IN CONTEMPORARY ART (3)

ARTH 770. SEMINAR IN LATIN-AMERICAN ART (3)
Prerequisite, ARTH 471 or permission of instructor.

ARTH 772. SEMINAR IN MODERN MEXICAN ART (3)
Prerequisite, ARTH 471 or permission of instructor. Problems of Mexican art of the 19th and 20th Centuries; Mexicanismo; the "Mural Renaissance"; architectural regionalism.

ARTH 774. SEMINAR IN 19TH CENTURY AMERICAN ART (3)
Problems in architecture and painting from the end of the Colonial Period until 1860.

ARTH 780. SEMINAR—PROBLEMS IN ARCHITECTURAL HISTORY AND CRITICISM (3)

ARTH 784. SEMINAR IN LITERARY SOURCES OF ART HISTORY (3)
Art historical sources from Pliny to Malraux.

ARTH 798. DIRECTED GRADUATE STUDIES IN ART HISTORY (3)

ARTH 799. MASTER'S THESIS RESEARCH (1-6)

ARTH 899. DOCTORAL DISSERTATION RESEARCH (1-8)

ART STUDIO

ARTS 404. EXPERIMENTS IN VISUAL PROCESSES (3)
Six hours per week. Prerequisites, either ARTS 220, 330 or 340. Investigation and execution of process oriented art. Group and individual experimental projects.

ARTS 410. DRAWING IV (3)
Six hours per week. Prerequisite, ARTS 310. Advanced drawing with emphasis on human figure, its structure and organic likeness to forms in nature. Compositional problems deriving from this relationship are also stressed.

ARTS 420. PAINTING IV (3)
Six hours per week. Prerequisite, ARTS 324. Creative painting. Emphasis on personal direction and self-criticism. Group seminars.

ARTS 430. SCULPTURE IV (3)
Six hours per week. Prerequisite, ARTS 335. Problems and techniques of newer concepts, utilizing various materials, such as plastics and metals. Technical aspects of welding stressed.

ARTS 440. PRINTMAKING III (3)
Six hours per week. Prerequisite, ARTS 340 and 344. Contemporary experimental techniques of one print medium with group discussions.

ARTS 441. PRINTMAKING IV (3)
Six hours per week. Prerequisite, ARTS 440. Continuation of ARTS 440.

ARTS 489. SPECIAL PROBLEMS IN STUDIO ART (3)
Prerequisite, consent of instructor. Repeatable to a maximum of six hours.

ARTS 498. DIRECTED STUDIES IN STUDIO ART (2-3)
For advanced students, by permission of department chairman. Course may be repeated for credit if content differs.

ARTS 610. DRAWING (3)
Sustained treatment of a theme chosen by student. Wide variety of media.

ARTS 614. DRAWING (3)
Traditional materials and methods including Oriental, Sumi ink drawing and techniques of classical European masters.

ARTS 616. DRAWING (3)
Detailed anatomical study of the human figure and preparation of large scale mural compositions.

ARTS 620. PAINTING (3)

ARTS 624. PAINTING (3)

ARTS 626. PAINTING (3)

ARTS 627. PAINTING (3)

ARTS 630. EXPERIMENTATION IN SCULPTURE (3)

ARTS 634. EXPERIMENTATION IN SCULPTURE (3)

ARTS 636. MATERIALS AND TECHNIQUES IN SCULPTURE (3)
For advanced students, methods of armature building and the use of a variety of stone, wood, metal, and plastic materials.

ARTS 637. SCULPTURE-CASTING AND FOUNDRY (3)
The traditional methods of plaster casting and the complicated types involving metal, cire perdue, sand-casting and newer methods, such as cold metal process.

ARTS 640. PRINTMAKING (3)
Advanced problems. Relief process.

ARTS 644. PRINTMAKING (3)
Advanced problems. Intaglio process.

ARTS 646. PRINTMAKING (3)
Advanced problems. Lithographic process.

ARTS 647. SEMINAR IN PRINTMAKING (3)

ARTS 689. SPECIAL PROBLEMS IN STUDIO ART (3)
Prerequisite, consent of instructor. Repeatable to a maximum of six hours.

ARTS 690. DRAWING AND PAINTING (3)
Preparation and execution of a wall decoration.

ARTS 698. DIRECTED GRADUATE STUDIES IN STUDIO ART (3)
For advanced graduate students by permission of head of department. Course may be repeated for credit if content differs.

ARTS 798. DIRECTED GRADUATE STUDIES IN STUDIO ART (3)

ARTS 799. MASTER'S THESIS RESEARCH (1-6)

ASTRONOMY PROGRAM

Professor and Director: Kerr
Professors: Brandt (part-time), Erickson, Kundu, Opik, Westerhout
Associate Professors: A'Hearn, Bell, Harrington, Matthews, Rose, Smith, Wentzel, Zipoy, Zuckerman
Assistant Professor: Simonson

The Astronomy Program, adminstratively part of the Department of Physics and Astronomy, offers programs of study leading to the degrees of M.S. and Ph.D. in Astronomy. The M.S. program includes both thesis and non-thesis options. Areas of specialization include: galactic structure, interstellar medium, extragalactic astronomy, stellar atmospheres, stellar evolution, solar physics, solar system, celectial mechanics, astronomical instrumentation.

Students are expected to demonstrate competence in the following subjects prior to admission to graduate work: general physics, heat, intermediate mechanics, optics, electricity and magnetism, modern physics, differential and integral calculus, and advanced calculus. A student may be admitted without one of these courses, but he should plan to make up the deficiency as soon as possible, either by including such a course as a part of his graduate program or by independent study.

No formal undergraduate course work in astronomy is required. However, an entering student should have a working knowledge of the basic facts of astronomy such as is obtainable from one of the many elementary textbooks. A more advanced knowledge of astronomy will of course enable a student to progress more rapidly during the first year of graduate work.

Normally, a satisfactory score on the GRE Advanced Test in Physics is required before an applicant's admission to The Graduate School will be considered. In special cases, the Graduate Entrance Committee may waive this requirement, and set other conditions as a requirement for admission, to be fulfilled either before admission or during the first year at Maryland.

A full schedule of courses in all fields of astronomy is offered including galactic astronomy, astrophysics, solar system astronomy, observational astronomy, celestial mechanics, solar physics, study of the interstellar medium and extra-galactic astronomy. The faculty has expertise in every major branch of astronomy. The research program is centered around two major areas of interest. The first one is the study of our galaxy: its large-scale spiral structure, detailed structure and theory of interstellar gas clouds, the theory of the interaction between cosmic rays and the gas, and the distribution of different types of stars. The second is the study of stellar atmospheres and interiors, including also the solar atmosphere, stellar evolution, and planetary nebulae. Research is also done on the physics of the solar system.

Qualification for the Ph.D. program (which is decided in the middle or at the end of the second year) requires a written examination on basic astronomy at the end of the first year and an extensive research project during the second year. Overall performance in the exam, course work and research determines admission to the Ph.D. program.

All candidates must take the courses ASTR 400, 401 and 410, 411 (this requirement may be waived if the student has previous experience). All full-time students are expected to attend an average of two colloquia and/or seminars each week by registering for ASTR 698. Candidates for the Ph.D. should expect to take at least four 3-credit Astronomy courses at the 600 and 700 level, exclusive of seminars and research projects. Normally all Ph.D. candidates take at least 12 credits of advanced physics courses. Especially recommended are PHYS 601, 604, and 622.

Many other courses of direct interest to astronomy students are available in Physics, Mathematics, Meteorology, Electrical Engineering, and Chemistry. The student is urged to obtain as wide a background as possible outside his field of specialization.

For more information, especially for physics courses related to astronomy, see the section on Physics. A brochure, entitled "Graduate Study in Astronomy," describing the requirements, the courses and the research program in detail is available from the department. All correspondence, including that concerning admission to the Astronomy Program, should be ad-

dressed to: Astronomy Program, University of Maryland, College Park, Maryland 20742.

ASTR 400. INTRODUCTION TO ASTROPHYSICS I (3)
Three lectures per week. Pre- or corequisite, PHYS 422 or consent of instructor. Spectroscopy, structure of the atmospheres of the sun and other stars. Observational data and curves of growth. Chemical composition.

ASTR 401. INTRODUCTION TO ASTROPHYSICS II (3)
Three lectures per week. Prerequisite, ASTR 400. A brief survey of stellar structure and evolution, and of the physics of low-density gasses, such as the interstellar medium and the solar atmosphere. Emphasis is placed on a good understanding of a few theoretical concepts that have wide astrophysical applications.

ASTR 410. OBSERVATIONAL ASTRONOMY (3)
Prerequisites, working knowledge of calculus, physics through PHYS 284, or 263, and 3 credits of astronomy. An introduction to current methods of obtaining astronomical information including radio, infrared, optical, ultra-violet, and X-ray astronomy. The laboratory work will involve photographic and photoelectric observations with the department's optical telescope and 21-cm line spectroscopy, flux measurements and interferometry with the department's radio telescopes.

ASTR 411. OBSERVATIONAL ASTRONOMY (3)
Prerequisites, ASTR 410, working knowledge of calculus, physics through PHYS 284, or 263, and 3 credits of astronomy. An introduction to current methods of obtaining astronomical information including radio, infrared, optical, ultra-violet, and X-ray astronomy. The laboratory work will involve photographic and photoelectric observations with the department's optical telescope and 21-cm line spectroscopy, flux measurements and interferometry with the department's radio telescopes. Observatory work in individual projects. Every semester.

ASTR 420. INTRODUCTION TO GALACTIC RESEARCH (3)
Three lectures per week. Prerequisite, MATH 141 and at least 12 credits of introductory physics and astronomy courses. Stellar motions, methods of galactic research, study of our own and nearby galaxies, clusters of stars.

ASTR 450. CELESTIAL MECHANICS (3)
Three lectures a week. Prerequisite, PHYS 410 or consent of instructor. Celestial mechanics, orbit theory, equations of motion.

ASTR 498. SPECIAL PROBLEMS IN ASTRONOMY (1-6)
Prerequisite, major in physics or astronomy and/or consent of advisor. Research or special study. Credit according to work done.

ASTR 600. STELLAR ATMOSPHERES (3)
Three lectures per week. Prerequisite, ASTR 400, 401, PHYS 422 or consent of the instructor. Observational methods, line formation, curve of growth, equation of transfer, stars with large envelopes, variable stars, novae, magnetic fields in stars.

ASTR 605. STELLAR INTERIORS (3)
Three lectures per week. Prerequisites, MATH 414 and PHYS 422 or consent of instructor. A study of stellar structure and evolution. This course will consider the question of energy transfer and generation in the interior of a star, the structure of stars, including problems of turbulence, determination of chemical composition, non-homogeneous stars, evolution of both young and old stars, pulsating stars, novae.

ASTR 620. GALACTIC RESEARCH (3)
Prerequisites, ASTR 420, 410, 411, or consent of the instructor. Current methods of research into galactic structure, kinematics, and dynamics. Basic dynamical theory. Optical and radio observational methods and current results. Review of presently-determined distribution and kinematics of the major constituents of the galaxy. Evolution of the galaxy.

ASTR 625. DYNAMICS OF STELLAR SYSTEMS (3)
Three lectures per week. Prerequisite, PHYS 601 or ASTR 420. Study of the structure and evolution of dynamical systems encountered in astronomy. Stellar encounters viewed as a two-body problem, statistical treatment of encounters, study of dynamical problems in connection with star clusters, ellipsoidal galaxies, nuclei of galaxies, high-velocity stars.

ASTR 630. PHYSICS OF THE SOLAR SYSTEM (3)
Three lectures per week. Prerequisite, PHYS 422. A survey of the problems of interplanetary space, the solar wind, comets and meteors, planetary structure and atmospheres, motions of particles in the Earth's magnetic field.

ASTR 660. PHYSICS OF THE SOLAR ENVELOPE (3)
Three lectures per week. Prerequisites, PHYS 422, ASTR 400 or consent of instructor. A detailed study of the solar atmosphere. Physics of solar phenomena, such as solar flares, structure of the corona, etc.

ASTR 670. INTERSTELLAR MATTER (3)
Three lectures per week. Prerequisites, previous or concurrent enrollment in PHYS 622, ASTR 400 or 420, or consent of instructor. A study of the physical properties of interstellar gas and dust. This course will include diffuse nebulae, regions of ionized hydrogen, regions of neutral hydrogen, the problems of interstellar dust and perhaps planetary nebulae, molecules.

ASTR 688. SPECIAL TOPICS IN MODERN ASTRONOMY (1-6)
Credit according to work done each semester. Prerequisite, consent of instructor. These courses will be given by specialists in various fields of modern astronomy, partly staff members, partly visiting professors of part-time lecturers. They will cover subjects such as: cosmology, discrete radio sources, magnetohydrodynamics in astronomy, the H.R. diagram, stellar evolution, external galaxies, galactic structure, chemistry of the interstellar medium, advanced celestial mechanics, astrometry, radio physics of the sun, etc.

ASTR 698. SEMINAR (1)
Seminars on various topics in advanced astronomy are held each semester, with the contents varied each year. One credit for each semester. There are weekly colloquia by staff, astronomers from the

Washington area, and visiting astronomers, usually on topics related to their own work.

ASTR 699. SPECIAL PROBLEMS IN ADVANCED ASTRONOMY (1-6)

ASTR 788. SPECIAL TOPICS IN MODERN ASTRONOMY (1-6)

ASTR 799. MASTER'S THESIS RESEARCH (1-6)

ASTR 899. DOCTORAL DISSERTATION RESEARCH (1-8)

BOTANY PROGRAM

Professor and Acting Chairman: Sisler
Professors: Corbett, Galloway, Gauch, Kantzes, Klarman, Krusberg, Lockard,[1] D. Morgan, Patterson, Stern
Associate Professors: Bean, Curtis, Karlander, Rappleye
Assistant Professors: Barnett, Motta, Reveal, Smith, Stevenson, Van Valkenburg
Research Professor: Sorokin

[1] joint appointment with Secondary Education

The Department of Botany offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy. Courses and research problems are developed on a personal basis arranged according to the intellectual and professional needs of the student. Course programs are flexible and are designed under close supervision by the student's adviser. The objective of the program is to equip the student with a background and techniques for a career in plant science in academic, governmental, industrial or private laboratories.

The areas of specialization are Anatomy and Morphology, Plant Biochemistry, Biophysics, Plant Ecology, Physiology of Fungi, Genetics and Molecular Biology, Marine Biology, Mycology, Plant Nematology, Plant Pathology, Phycology, Plant Physiology, Taxonomy, and Plant Virology.

There are no special admission requirements. However, a high degree of intellectual excellence is of greater consequence than completion of a particular curriculum at the undergraduate level.

The degree requirements are flexible. However, they involve demonstration of competence in the broad field of Botany, as well as completion of courses in other disciplines which are supportive of modern competence in this field.

The department has laboratories equipped to investigate most phases of botanical and molecular biological research. Field and greenhouse facilities are available for research requiring plant culture. Special laboratory rooms have been developed for research employing radioactive isotopes. Major pieces of equipment include a transmission electron microscope, ultracentrifuges, X-ray equipment, low-speed centrifuges, microtomes for cutting ultrathin sections, infra-red spectrophotometer, recording spectrophotometers, research bers, Herbarium, departmental reference room, enzyme preparation rooms, dark rooms, cold rooms, special culture apparatus for algae, fungi, and higher plants, spectrophotometers, and respirometers are among the many special pieces of equipment and facilities that are available for research.

BOTN 401. HISTORY AND PHILOSOPHY OF BOTANY (1)
Prerequisites, 20 semester credit hours in biological sciences including BOTN 100 or equivalent. Discussion of the development of ideas and knowledge about plants, leading to a survey of contemporary work in botanical science.

BOTN 402. PLANT MICROTECHNIQUE (3)

BOTN 405. SYSTEMATIC BOTANY (3)
Two 2-hour laboratory periods a week. Prerequisite, BOTN 212 or equivalent. An advanced study of the principles of systematic botany. Laboratory practice with difficult plant families including grasses, sedges, legumes, and composites. Field trips arranged.

BOTN 407. TEACHING METHODS IN BOTANY (2)
Summer session. Four 2-hour laboratory demonstration periods per week, for 8 weeks. Prerequisite, BOTN 100 or equivalent. A study of the biological principles of common plants, and demonstrations, projects, and visual aids suitable for teaching in primary and secondary schools.

BOTN 411. PLANT ANATOMY (3)
Summer or University College. Lectures and labs to be arranged. The origin and development of the organs and the tissue systems in the vascular plants.

BOTN 413. PLANT GEOGRAPHY (2)
Prerequisite, BOTN 100 or equivalent. A study of plant distribution throughout the world and the factors generally associated with such distribution.

BOTN 414. PLANT GENETICS (3)
Prerequisite, BOTN 100 or equivalent. The basic principles of plant genetics are presented; the mechanics of transmission of the hereditary factors in relation to the life cycle of seed plants, the genetics of specialized organs and tissues, spontaneous and induced mutations, gene action, genetic maps, the fundamentals of polyploidy, and genetics in relation to methods of plant breeding are the topics considered.

BOTN 415. PLANTS AND MANKIND (2)
Prerequisite, BOTN 100 or equivalent. A survey of the plants which are utilized by man, the diversity of such utilization, and their historic and economic significance.

BOTN 416. PRINCIPLES OF PLANT ANATOMY (4)
Two lectures and two 2-hour laboratory periods per week. The origin and development of cells, tissues, and tissue systems of vascular plants with special emphasis on seed-bearing plants. Particular stress is given to the comparative, systematic, and evolutionary study of the structural components of the plants. Prerequisite, general botany.

BOTN 417. FIELD BOTANY AND TAXONOMY (2)
Summer session. Prerequisite, BOTN 100 or general biology. Four 2-hour laboratory periods a week for 8 weeks. The identification of trees, shrubs, and herbs, emphasizing the native plants of Maryland. Manuals, keys, and other techniques will be used.

Numerous short field trips will be taken. Each student will make an individual collection.

BOTN 422. RESEARCH METHODS IN PLANT PATHOLOGY (2)
Two laboratory periods a week. Prerequisite, BOTN 221 or equivalent. Advanced training in the basic research techniques and methods of plant pathology.

BOTN 424. DIAGNOSIS AND CONTROL OF PLANT DISEASES (3)
Prerequisite, BOTN 221. Three lectures per week. A study of various plant diseases grouped according to the manner in which the host plants are affected. Emphasis will be placed on recognition of symptoms of the various types of diseases and on methods of transmission and control of the pathogens involved.

BOTN 426. MYCOLOGY (4)
Two lectures and two 2-hour laboratory periods per week. An introductory study of the morphology, classification, life histories, and economics of the fungi.

BOTN 427. FIELD PLANT PATHOLOGY (1)
Summer session: lecture and laboratory to be arranged. Prerequisite, BOTN 221, or equivalent. The techniques of pesticide evaluation and the identification and control of diseases of Maryland crops are discussed. Offered in alternate years or more frequently with demand.

BOTN 441. PLANT PHYSIOLOGY (4)
Two lectures and one 4-hour laboratory period a week. Prerequisites, BOTN 100 and general chemistry. Organic chemistry strongly recommended. A survey of the general physiological activities of plants.

BOTN 462. PLANT ECOLOGY (2)
Prerequisite, BOTN 100. Two lectures per week. The dynamics of populations as affected by environmental factors with special emphasis on the sturcture and composition of natural plant communities, both terrestrial and aquatic.

BOTN 463. ECOLOGY OF MARSH AND DUNE VEGETATION (2)
Two lectures a week. Prerequisite, BOTN 100. An examination of the biology of higher plants in dune and marsh ecosystems.

BOTN 464. PLANT ECOLOGY LABORATORY (1)
Prerequisite, BOTN 462 or its equivalent or concurrent enrollment therein. One 3-hour laboratory period a week. The application of field and experimental methods to the qualitative and quantitative study of vegetation and environmental factors.

BOTN 475. ALGAL SYSTEMATICS (3)
One lecture and two laboratory periods per week. Prerequisite, BOTN 100. An intensive study of algal structures, morphology, classification and nomenclature including preparation, preservation and identification procedures.

BOTN 477. MARINE PLANT BIOLOGY (4)
Summer session. Prerequisites, BOTN 100 or general biology plus organic chemistry or the consent of the instructor. Five 1-hour lectures and three 3-hour laboratories each week for six weeks. An introduction to taxonomic, physiological and biochemical characteristics of marine plants which are basic to their role in the ecology of the oceans and estuaries.

BOTN 497. SPECIAL PROBLEMS IN MARINE RESEARCH (1-3)
Summer session. Prerequisites, BOTN 100 or general biology plus organic chemistry or consent of instructor. Recommended concurrent or previous enrollment in BOTN 477, Marine Plant Biology. An experimental approach to problems in marine research dealing primarily with phytoplankton, the larger algae, and marine spermatophytes. Emphasis will be placed on their physiological and biochemical activities.

BOTN 612. PLANT MORPHOLOGY (3)
One lecture and two laboratory periods per week. Prerequisites, BOTN 212, BOTN 416, or equivalent. A comparative study of the morphology of the flowering plants, with special reference to the phylogeny and development of floral organs.

BOTN 615. PLANT CYTOGENETICS (3)
Two lectures and one laboratory period a week. Prerequisite, Introductory Genetics. An advanced study of the current status of plant genetics, particularly gene mutations and their relation to chromosome changes in corn and other favorable materials.

BOTN 616. NUCLEIC ACIDS AND MOLECULAR GENETICS (2)
Prerequisites, biochemistry (CHEM 661) and cytogenetics (BOTN 615) or equivalent, or consent of instructor. One session of two hours per week. An advanced treatment of the biochemistry of nucleic acids and molecular genetics for qualified graduate students. Lectures and assigned reports on recent progress in the chemistry of inheritance.

BOTN 621. PHYSIOLOGY OF FUNGI (2)
Prerequisites, organic chemistry and BOTN 441 or equivalent in bacterial or animal physiology. A study of various aspects of fungal metabolism, nutrition, biochemical transformation, fungal products and mechanism of fungicidal action.

BOTN 623. PHYSIOLOGY OF FUNGI LABORATORY (1)
One laboratory period per week. Prerequisites, BOTN 621 or concurrent registration therein. Application of equipment and techniques in the study of fungal physiology.

BOTN 625. PHYSIOLOGY OF PATHOGENS AND HOST-PATHOGEN RELATIONSHIPS (3)
Three lecture periods a week. A study of enzymes, toxins, and other factors involved in pathogenicity and the relationship of host-pathogen interaction to disease development.

BOTN 632. PLANT VIROLOGY (2)
Two lectures per week on the biological, biochemical, and biophysical aspects of viruses and virus diseases of plants. Prerequisites, Bachelor's degree or equivalent in any biological science and permission of instructor.

BOTN 634. PLANT VIROLOGY LABORATORY (2)
Two laboratories per week on the application and techniques for studying the biological, biochemical

and biophysical aspects of plant viruses. Prerequisites, Bachelor's degree or equivalent in any biological science and BOTN 632 or concurrent registration therein, and permission of the instructor.

BOTN 636. PLANT NEMATOLOGY (4)
Two lectures and two laboratory periods a week. Prerequisite, BOTN 221 or permission of instructor. The study of plant-parasitic nematodes, their morphology, anatomy, taxonomy, genetics, physiology, ecology, host-parasite relations and control. Recent advances in this field will be emphasized.

BOTN 641. ADVANCED PLANT PHYSIOLOGY (2)
Prerequisites, BOTN 441 or equivalent, and organic chemistry. A presentation of the metabolic processes occurring in plants, including the roles of the essential elements in these processes with special emphasis on recent literature.

BOTN 642. PLANT BIOCHEMISTRY (2)
Prerequisite, BOTN 641 or CHEM 461 and 462. A treatment of those aspects of biochemistry especially pertinent to plant-respiration, photosynthesis, and organic transformations.

BOTN 644. PLANT BIOCHEMISTRY LABORATORY (2)
Prerequisite, BOTN 642 or concurrent registration therein. Use of apparatus and application of techniques in the study of the chemistry of plants and plant materials. One scheduled 3-hour laboratory period per week, plus one 1-hour laboratory to be arranged.

BOTN 645. GROWTH AND DEVELOPMENT (2)
Prerequisite, 12 semester hours of plant science. A study of current developments in the mathematical treatment of growth and the effects of radiation, plant hormones, photoperiodism, and internal biochemical balance during the development of the plant.

BOTN 652. PLANT BIOPHYSICS (2)
Prerequisites, BOTN 641 and at least one year in physics. An advanced course dealing with the operation of physical phenomena in plant life processes.

BOTN 654. PLANT BIOPHYSICS LABORATORY (2)
Plant biophysics laboratory. Prerequisite, BOTN 652 or concurrent registration therein. A quantitative and qualitative study of plant systems by physical and physiochemical methods and instruments. One scheduled 3-hour laboratory period per week, plus one 1-hour laboratory period to be arranged.

BOTN 661. ADVANCED PLANT ECOLOGY (3)
Prerequisite, a working knowledge of elementary genetics and calculus, or permission of the instructor. Population dynamics, evolutionary mechanisms, and quantitative aspects of the analysis of natural communities. Special emphasis will be given to recent theoretical developments.

BOTN 672. PHYSIOLOGY OF ALGAE (2)
Prerequisite, BOTN 642, the equivalent in allied fields, or permission of the instructor. A study of the physiology and comparative biochemistry of the algae. Laboratory techniques and recent advances in algal nutrition, photosynthesis, and growth will be reviewed.

BOTN 674. PHYSIOLOGY OF ALGAE LABORATORY (1)
One laboratory period a week. Prerequisites, previous or concurrent enrollment in BOTN 672, and permission of instructor. Special laboratory techniques involved in the study of algal nutrition.

BOTN 698. SEMINAR IN BOTANY (1)
First and second semesters, Prerequisite, permission of the instructor. Discussion of special topics and current literature in all phases of botany.

BOTN 699. SPECIAL PROBLEMS IN BOTANY (1-3)
a. physiology, b. ecology, c. pathology, d. mycology, e. nematology, f. cytology, g. cytogenetics, h. morphology, i. anatomy, j. taxonomy. First and second semesters. Credit according to time scheduled and organization of course. Maximum credit toward an advanced degree for the individual student at the discretion of the Department. This course may be organized as a lecture series on a specialized advanced topic or may consist partly, or entirely, of experimental procedures. It may be taught by visiting lecturers, or by resident staff members.

BOTN 799. MASTER'S THESIS RESEARCH (1-6)

BOTN 899. DOCTORAL DISSERTATION RESEARCH (1-8)

BUSINESS ADMINISTRATION PROGRAM

Professor and Dean: Lamone

Professors: H. Anderson, Carroll, Dawson, Fisher, Greer, Hille, Locke, Levine, Taff, Wright

Associate Professors: Ashmen, Fromovitz, Gannon, Haslem, Hynes, Leete, Loeb, Nash, Nickels, Olson, Paine, Spivey, Thieblot, Widhelm

Assistant Professors: R. Anderson, Corwin, Falthzik, Handorf, Hargrove, Jolson, Kuehl, May, Poist

The College of Business and Management offers graduate work leading to the degrees of Master of Business Administration and Doctor of Business Administration. Areas of specialization include: accounting, finance, marketing, personnel and industrial relations, management and organization theory, transportation, management science and statistics.

MASTER OF BUSINESS ADMINISTRATION

The Master of Business Administration (MBA) program is designed to prepare students for administrative or managerial positions of responsibility in industry, commerce, or government. Emphasis is placed on the development of analytical ability and reasoned judgment in decision making.

Qualified individuals with undergraduate specialties in engineering, science, arts, humanities, and other fields are accepted as well as those who specialized in undergraduate business administration. However, all students are required to complete or have completed certain basic courses in business and economics with a "B" average. These preparatory courses are: princi-

ples of economics (6 hours), principles of accounting (6 hours), business law (3 hours), statistics (3 hours), marketing (3 hours), management and organization theory (3 hours), and business finance (3 hours). Students must also complete or have completed mathematics through elementary differential and integral calculus.

If any candidate has not completed the above basic courses when entering the program, he must do so as early as possible in his graduate work. They do not count towards the 30 semester hours which must be completed in courses numbered 600 or above for the MBA.

The MBA program is offered only during the day and is conducted on the campus. No thesis is required. The Admission Test for Graduate Study in Business must be taken before applying for admission to the program.

Of the 30 hours required in graduate courses numbered 600 or above, 12 will be taken in a mandatory core, at least 6 and not more than 12 will be taken in a major subject, and the balance will be electives.

The mandatory core embraces areas of business decisions central to the firm's operation. It covers relevant analytical methods and quantitative techniques, behavioral factors which affect the managerial task, and the economic, social, and regulatory environment in which the firm operates.

The major subject may be chosen from any of the fields of special interest included among the following five concentrations: financial administration (accounting or finance), human behavior in business (organization theory or personnel, or industrial relations), marketing-logistics (marketing, transportation, or logistics), management science-statistics (either one), and general management.

Electives must be taken outside the major and must form a coherent group, as approved by the student's advisor.

DOCTOR OF BUSINESS ADMINISTRATION

The Doctor of Business Administration (DBA) program is designed for those planning careers in research, service, and university-level teaching as well in professional management and government. Students with masters- level or undergraduate concentrations in areas other than business administration may also be admitted to the program. No foreign language is required. The DBA program is offered only during the day. The Admission Test for Graduate Study in Business is required.

The DBA program requires a minimum of 60 or 72 semester hours (depending on individual student background). A major area is chosen, but competence must be developed in all of the five concentrations noted above in the MBA program, and must be demonstrated by passing written examinations in each. Following the written examinations, each candidate must pass an oral examination given by a committee of the departmental graduate faculty.

The dissertation must exhibit competence in analysis, interpretation, and presentation of research findings, and should be a major contribution to the literature of the field.

BSAD 401. INTRODUCTION TO SYSTEMS ANALYSIS (3)
Students enrolled in the Department of Business Administration curricula will register for IFSM 436. For detailed information on prerequisites and descriptions of the course, refer to IFSM 436. The credits earned in IFSM 436 may be included in the total credits earned in the area of concentration in business administration.

BSAD 420, 421. UNDERGRADUATE ACCOUNTING SEMINAR (3)
Prerequisite, senior standing as an accounting major or consent of instructor. Enrollment limited to upper one-third of senior class. Seminar coverage of outstanding current non-text literature, current problems and case studies in accounting.

BSAD 422. AUDITING THEORY AND PRACTICE (3)
Prerequisite, BSAD 311. A study of the principles and problems of auditing and application of accounting principles to the preparation of audit working papers and reports.

BSAD 423. APPRENTICESHIP IN ACCOUNTING (0)
Prerequisites, minimum of 20 semester hours in accounting and the consent of the accounting staff. A period of apprenticeship is provided with nationally known firms of certified public accountants from about January 15 to February 15.

BSAD 424. ADVANCED ACCOUNTING (3)
Prerequisite, BSAD 311. Advanced accounting theory to specialized problems in partnerships, ventures, consignments, installment sales, insurance, statement of affairs, receiver's accounts, realization and liquidation reports, and consolidation of parent and subsidiary accounts.

BSAD 425. CPA PROBLEMS (3)
Prerequisite, BSAD 311, or consent of instructor, a study of the nature, form and content of C.P.A. examinations by means of the preparation of solutions to, and an analysis of, a large sample of C.P.A. problems covering the various accounting fields.

BSAD 426. ADVANCED COST ACCOUNTING (2)
Prerequisite, BSAD 321. A continuation of basic cost accounting with special emphasis on process costs, standard costs, joint costs, and by-product cost.

BSAD 427. ADVANCED AUDITING THEORY AND PRACTICE (3)
Prerequisite, BSAD 422. Advanced auditing theory and practice and report writing.

BSAD 430. LINEAR STATISTICAL MODELS IN BUSINESS (3)
Prerequisite, BSAD 231 or consent of instructor. Model building involving an intensive study of the general linear stochastic model and the applications of this model to business problems. The model is derived in matrix form and this form is used to analyze both the regression and ANOVA formulations of the general linear model.

BSAD 431. DESIGN OF STATISTICAL EXPERIMENTS IN BUSINESS (3)
Prerequisite, BSAD 230 or BSAD 231. Surveys ANOVA models, basic and advanced experimental design concepts. Non-parametric tests and correla-

tion are emphasized. Applications of these techniques to business problems in primarily the marketing and behavioral sciences are stressed.

BSAD 432. SAMPLE SURVEY DESIGN FOR BUSINESS AND ECONOMICS (3)
Prerequisite, BSAD 230 or BSAD 231. Design of probability samples. Simple random sampling, stratified random sampling, systematic sampling, and cluster sampling designs are developed and compared for efficiency under varying assumptions about the population sampled. Advanced designs such as multistage cluster sampling and replicated sampling are surveyed. Implementing these techniques in estimating parameters of business models is stressed.

BSAD 433. STATISTICAL DECISION THEORY IN BUSINESS (3)
Prerequisite, BSAD 231 or consent of the instructor. Bayesian approach to the use of sample information in decision-making. Concepts of loss, risk, decision criteria, expected returns, and expected utility are examined. Application of these concepts to decision-making in the firm in various contexts are considered.

BSAD 434. OPERATIONS RESEARCH I (3)
Prerequisite, BSAD 231 and MATH 240, or permission of instructor. Designed primarily for students majoring in Management Science, Statistics and Information Systems Management. It is the first semester of a two semester introduction to the philosophy, techniques, and applications of Operations Research. Topics covered include linear programming, postoptimality analysis, network algorithms, dynamic programming, inventory and equipment replacement models.

BSAD 435. OPERATIONS RESEARCH II (3)
Prerequisite, BSAD 434, or permission of instructor. The second semester of a two-part introduction to Operations Research. The primary emphasis is on stochastic models in management science. Topics include stochastic linear programming, probabilistic dynamic programming, Markov processes, probabilistic inventory models, queueing theory and simulation.

BSAD 436. APPLICATIONS OF MATHEMATICAL PROGRAMMING IN MANAGEMENT SCIENCE (3)
Prerequisite, BSAD 434 or permission of instructor. Theory and applications of linear, integer, and nonlinear programming models to management decisions. Topic covered include the basic theorems of linear programming; the matrix formulation of the simplex, the dual simplex algorithms; decomposition, cutting plane, branch and bound, and implicit enumeration algorithms; gradient based algorithms; and quadratic programming. Special emphasis is placed upon model formuation and solution using prepared computer algorithms.

BSAD 438. TOPICS IN STATISTICAL ANALYSIS FOR BUSINESS MANAGEMENT (3)
Prerequisite, BSAD 430 and MATH 240 or permission of the instructor. Selected topics in statistical analysis which are relevant to management for students with knowledge of basic statistical methods. Topics include evolutionary operation and response surface analysis, forecasting techniques, pathologies of the linear model and their remedies, multivariate statistical models, and non-parametric models.

BSAD 440. FINANCIAL MANAGEMENT (3)
Prerequisite, BSAD 340. Analysis and discussion of cases and readings relating to financial decisions of the firm. The application of finance concepts to the cases and readings relating to financial decisions of solution of financial problems is emphasized.

BSAD 443. SECURITY ANALYSIS AND VALUATION (3)
Prerequisite, BSAD 343. Study and application of the concepts, methods, models, and empirical findings to the analysis, valuation, and selection of securities, especially common stock.

BSAD 445. COMMERCIAL BANK MANAGEMENT (3)
Prerequisites, BSAD 340 and ECON 430. Analysis and discussion of cases and readings in commercial bank management. The loan function is emphasized; also the management of liquidity reserves, investments for income, and source of funds. Bank objectives, functions, policies, organization, structure, services, and regulation are considered.

BSAD 450. MARKETING RESEARCH METHODS (3)
Prerequisites, BSAD 230 and 350. Recommended that BSAD 430 be taken prior to this course. This course is intended to develop skill in the use of scientific methods in the acquisition, analysis and interpretation of marketing data. It covers the specialized fields of marketing research; the planning of survey projects, sample design, tabulation procedure and report preparation.

BSAD 451. CONSUMER ANALYSIS (3)
Prerequisites, BSAD 350 and 351. Recommended that PSYC 100 and 221 be taken prior to this course. Considers the growing importance of the American consumer in the marketing system and the need to understand him. Topics include the foundation considerations underlying consumer behavior such as economic, social, psychological and cultural factors. Analysis of the consumer in marketing situations—as a buyer and user of products and services—and in relation to the various individual social and marketing factors affecting his behavior. The influence of marketing communications is also considered.

BSAD 452. PROMOTION MANAGEMENT (3)
Prerequisites, BSAD 350 and 352. This course is concerned with the way in which business firms use advertising, personal selling, sales promotion, and other methods as part of their marketing program. The case study method is used to present problems taken from actual business practice. Cases studied illustrate problems in the use and coordination of demand stimulation methods as well as analysis and planning. Research, testing and statistical control of promotional activities are also considered.

BSAD 453. INDUSTRIAL MARKETING (3)
Prerequisites, BSAD 350 plus one other marketing course. The industrial and business sector of the marketing system is considered rather than the household or ultimate consumer sector. Industrial products range from raw materials and supplies to the major equipment in a plant, business office, or institution. Topics include product planning and in-

troduction, market analysis and forecasting, channels, pricing, field sales force management, advertising, marketing cost analysis, and government relations. Particular attention is given to industrial, business and institutional buying policies and practice and to the analysis of buyer behavior.

BSAD 454. INTERNATIONAL MARKETING (3)
Prerequisites, BSAD 350 plus any other marketing course. A study of the marketing functions from the viewpoint of the international executive. In addition to the coverage of international marketing policies relating to product adaptation, data collection and analysis, channels of distribution, pricing, communications, and cost analysis, consideration is given to the cultural, legal, financial, and organizational aspects of international marketing.

BSAD 455. SALES MANAGEMENT (3)
The role of the sales manager, both at headquarters and in the field, in the management of people, resources and marketing functions. An analysis of the problems involved in sales organization, forecasting, planning, communicating, evaluating and controlling. Attention is given to the application of quantitative techniques and pertinent behavioral science concepts in the management of the sales effort and sales force.

BSAD 460. PERSONNEL MANAGEMENT—ANALYSIS AND PROBLEMS (3)
Prerequisite, BSAD 360. Recommended, BSAD, 230. Research findings, special readings, case analysis, simulation, and field investigations are used to develop a better understanding of personnel problems, alternative solutions and their practical ramifications.

BSAD 462. LABOR LEGISLATION (3)
Case method analysis of the modern law of industrial relations. Cases include the decisions of administrative agencies, courts and arbitration tribunals.

BSAD 464. ORGANIZATIONAL BEHAVIOR
Prerequisite, BSAD 364. An examination of research and theory concerning the forces which contribute to the behavior of organizational members. Topics covered include: work group behavior, supervisory behavior, intergroup relations, employee goals and attitudes, communication problems, organizational change, and organizational goals and design.

BSAD 467. UNDERGRADUATE SEMINAR IN PERSONNEL MANAGEMENT (3)
Prerequisite, consent of instructor. This course is open only to the top one-third of undergraduate majors in personnel and labor relations and is offered during the fall semester of each year. Highlights major developments. Guest lecturers make periodic presentations.

BSAD 470. MOTOR TRANSPORTATION (3)
Prerequisite, BSAD 370. The development and scope of the motor carrier industry; different types of carriers, economics of motor transportation, service available, federal regulation, highway financing, allocation of cost to highway users, highway barriers.

BSAD 471. WATER TRANSPORTATION (3)
Prerequisite, BSAD 370. Water carriers of all types, development and types of services, trade routes, inland waterways, company organization, the American merchant marine as a factor in national activity.

BSAD 472. COMMERCIAL AIR TRANSPORTATION (3)
Prerequisite, BSAD 370. The air transportation system of the United States; airways, airports, airlines. Federal regulation of air transportation; economics, equipment, operations, financing, selling of passenger and cargo services. Air mail development and services.

BSAD 473. ADVANCED TRANSPORTATION PROBLEMS (3)
Prerequisite, BSAD 370. A critical examination of current government transportation policy and proposed solutions. Urban and intercity managerial transport problems are also considered.

BSAD 474. URBAN TRANSPORT AND URBAN DEVELOPMENT (3)
Prerequisite, ECON 203 or 205. An analysis of the role of urban transportation in present and future urban development. The interaction of transport pricing and service, urban planning, institutional restraints, and public land uses is studied.

BSAD 480. LEGAL ENVIRONMENT OF BUSINESS (3)
The course examines the principal ideas in law stressing those which are relevant for the modern business executive. Legal reasoning as it has evolved in this country will be one of the central topics of study. Several leading antitrust cases will be studied to illustrate vividly the reasoning process as well as the interplay of business, philosophy, and the various conceptions of the nature of law which give direction to the process. Examination of contemporary legal problems and proposed solutions, especially those most likely to affect the business community, are also covered.

BSAD 481. PUBLIC UTILITIES (3)
Prerequisite, ECON 203 or 205. Using the regulated industries as specific examples, attention is focused on broad and general problems in such diverse fields as constitutional law, administrative law, public administration, government control of business, advanced economic theory, accounting, valuation and depreciation, taxation, finance, engineering, and management.

BSAD 482. BUSINESS AND GOVERNMENT (3)
Prerequisite, ECON 203 or 205. A study of the role of government in modern economic life. Social control of business as a remedy for the abuses of business enterprise arising from the decline of competition. Criteria of limitations on government regulation of private enterprise.

BSAD 485. ADVANCED PRODUCTION MANAGEMENT (3)
Prerequisite, BSAD 385. A study of typical problems encountered by the factory manager. The objective is to develop the ability to analyze and solve problems in management control of production and in the formulation of production policies. Among the topics covered are plant location, production planning and control, methods analysis, and time study.

BSAD 490. URBAN LAND MANAGEMENT (3)
Covers the managerial and decision making aspects

of urban land and property. Included are such subjects as land use and valuation matters.

BSAD 493. HONORS STUDY (3)
First semester of the senior year. Prerequisite, candidacy for honors in Business Administration. The course is designed for honors students who have elected to conduct intensive study (independent or group). The student will work under the direct guidance of a faculty advisor and the chairman of the honors committee. They shall determine that the area of study is of a scope and intensity deserving of a candidate's attention. Formal written and/or oral reports on the study may be required by the faculty advisor and/or chairman of the honors program. Group meetings of the candidates may be called at the discretion of the faculty advisors and/or chairman of the honors committee.

BSAD 494. HONORS STUDY (3)
Second semester of the senior year. Prerequisite, BSAD 493, and continued candidacy for honors in business administration. The student shall continue and complete the research initiated in BSAD 493, additional reports may be required at the discretion of the faculty advisor and honors program chairman. Group meetings may be held.

BSAD 495. BUSINESS POLICIES (3)
Prerequisites, BSAD 340, 350, 364 and senior standing. A case study course in which the aim is to have the student apply what he has learned of general management principles and their specialized functional applications of the overall management function in the enterprise.

BSAD 710. ADVANCED ACCOUNTING THEORY (3)
The study of the theoretical and conceptual foundations for generally accepted accounting principles and practices. Recent and current literature and ideas are studied in depth to provide coverage of the basic postulates, assumptions, and standards which underlie the measurement criteria and practices of financial accounting.

BSAD 720. MANAGERIAL ACCOUNTING I (3)
The use of accounting data for corporate financial planning and control. Topics included are organization for control, profit planning, budgeting, relevant costing, return on investment, and administration of the controllership function in smaller organizations. BSAD 720 or 740 is required of M.B.A. candidates.

BSAD 730. STATISTICAL ANALYSIS AND BUSINESS DECISIONS (3)
This course acquaints students with the 'Bayesian' approach to decision-making. Topics include: a review of basic probability concents and theorems; the relationship between expected utility and rational action; incremental analysis; partial expectations; linear profits and costs; opportunity loss and the cost of uncertainty; conditional and joint probability; the binomial, Pascal, Poisson, Gamma, and normal probability distributions; the revision of probabilities in the light of new information; preposterior analysis and sequential decision procedures.

BSAD 731. THEORY OF SURVEY DESIGN (3)
Examines the usefulness of statistical principles in survey design. Topics include: the nature of statistical estimation, the differential attributes of different estimators, the merits and weaknesses of available sampling methods and designs, the distinctive aspects of simple random samples, stratified random samples, and cluster samples, ratio estimates and the problems posed by biases and non-sampling errors.

BSAD 732. CONCEPTS AND METHODS OF EXPERIMENTAL STATISTICS (3)
Prerequisites, BSAD 730 (BSAD 330 highly desirable). Topical coverage includes the median test for 2 samples, Wilcoxon-Mann-Whitney test, Mood's square rank test for dispersion, contingency table analysis, tetrachoric and rank correlation, analysis of variance and covariance, discriminatory analysis and factor analysis. The course will use BMD class M, class V and class S programs or other 'canned' programs.

BSAD 734. INTRODUCTION TO MANAGEMENT SCIENCE
Required of M.B.A. and D.B.A. candidates. The processes, tools, and methodological problems in applying management science to aid managerial decision-making. Deals with the relationship of other quantitative aids to managerial actions such as economic analysis and systems analysis.

BSAD 735. APPLICATION OF MANAGEMENT SCIENCE (3)
Prerequisites, BSAD 734 or consent of the instructor. This course will expose the student to the successes and difficulties experienced in applying operations research to management decision making in all functional areas. The examination of 'classical' and contemporary applications in the literature and case studies will be emphasized.

BSAD 736. PHILOSOPHY AND PRACTICE OF MANAGEMENT SCIENCE (3)
Prerequisites, completion of any two graduate level operations research courses and a graduate level behavioral course, or consent of instructor.

BSAD 737. MANAGEMENT SIMULATION (3)
Prerequisite, BSAD 734 and consent of instructor. Deals with the development, manipulation, and validity of an operational model. Production information and other decision systems of concern to management will be studied. Manipulation of parameter values, assumptions, and conditions are studied. This is accomplished in conjunction with the use of computer facilities at the Computer Science Center on campus.

BSAD 740. FINANCIAL ADMINISTRATION (3)
The role of the financial manager in executive decision making. Financial planning, analysis, and control in such areas as the allocation of financial resources within the firm, forecasting and budgeting, capital budgeting and the bases for investment decisions, alternative sources of short-term and long-term financing and financial problems of growth. BSAD 720 or 740 is required of M.B.A. candidates.

BSAD 743. INVESTMENT ANALYSIS (3)
Evaluation of debt and equity security alternatives available for the employment of the investment fund. Analysis of economic and financial data of the na-

tional economy, the industry, and the company to arrive at the fundamental value of a security. Study of securities markets as independent regulators of investment values. Motives, needs, and basic ingredients in the selection and supervision of the portfolio.

BSAD 750. MARKETING ADMINISTRATION (3)
Required for M.B.A. candidates with concentrations in marketing. Principal objectives are: to develop an understanding of the problems and goals of marketing executives, to develop competence in the analysis and solution of marketing problems and to evaluate specific marketing efforts as they contribute to a coordinated total marketing program. Attention will be focused on product, price, and service policies, market characteristics, channel selection, promotional policies and organization structure.

BSAD 751. MARKETING COMMUNICATIONS MANAGEMENT (3)
Required for M.B.A. candidates concentrating in marketing, concerned with the part that advertising, promotion, public relations and related efforts play in the accomplishment of a firm's total marketing objectives. Its purpose is to develop competence in the formulation of mass communications, objectives in budget optimization, media appraisal, theme selection, program implementation and management, and results measurement.

BSAD 752. MARKETING RESEARCH METHODS (3)
Required for M.B.A. candidates concentrating in marketing, deals with the process of acquiring, classifying and interpreting primary and secondary marketing data needed for intelligent, profitable marketing decisions. Through readings, discussion, and case studies, efforts are made to develop skill in evaluating the appropriateness of alternative methodologies such as the inductive, deductive, survey, observational, and experimental. Consideration is also given to recent developments in the systematic recording and use of internal and external data needed for marketing decisions.

BSAD 753. INTERNATIONAL MARKETING (3)
Deals with environmental, organizational, and financial aspects of international marketing as well as problems of marketing research, pricing, channels of distribution, product policy, and communications which face U.S. firms trading with foreign firms or which face foreign firms in their operations.

BSAD 760. PERSONNEL MANAGEMENT—MANPOWER PROCUREMENT AND DEVELOPMENT (3)
An 'in depth' treatment of problems and techniques involved in obtaining and developing a competent work force, manpower forecasting, job analysis, time study, recruitment techniques, psychological tests, interviews, application blanks, references, programmed instruction role playing, and sensitivity training are typical topics included.

BSAD 761. PERSONNEL MANAGEMENT—MANPOWER COMPENSATION AND EVALUATION (3)
After a work force has been assembled and developed (BSAD 760), the manager must see to it that its potential is converted into efficient and continuing performance. This course provides an 'in depth' analysis of the role of employee compensation and appraisal in accomplishing this end. Typical topics include wage theory, incentive systems, wage decision criteria, job evaluation, profit sharing, wage surveys, forced choice rating, critical incidents, appraisal interviews, and fringe benefits.

BSAD 762. COLLECTIVE BARGAINING—CURRENT PROBLEMS AND ISSUES (3)
Includes such topics as methods of handling industrial disputes, legal restrictions on various collective bargaining activities, theory and philosophy of collective bargaining, and internal union problems.

BSAD 763. ADMINISTRATION OF LABOR RELATIONS (3)
Deals with labor relations at the plant level. Emphasizes the negotiation and administration of labor contracts. Includes union policy and influence on personnel management activities.

BSAD 764. BEHAVIORAL FACTORS IN MANAGEMENT (3)
Required of M.B.A. candidates. A critical analysis of the impact of the behavioral sciences on traditional concepts of management as process and as organization. Included within the area of analysis are such subjects as human motivation, human relations, morale, status, role, organization, communication, bureaucracy, the executive role, leadership and training.

BSAD 765. APPLICATION OF BEHAVIORAL SCIENCE TO BUSINESS (3)
Prerequisite, BSAD 764 or permission of professor. Stresses case analysis of behavioral knowledge applied to management problems. Typical topics include analysis of modes for introducing change, group versus organizational goals, organizational barriers to personal growth, the effect of authority systems on behavior, and the relationship between technology and social structure.

BSAD 770. TRANSPORTATION THEORY AND ANALYSIS (3)
Examines the transportation system and its components. Key topics in the development and present form of transportation in both the United States and other countries are considered together with theoretical concepts employed in the analysis of transport problems.

BSAD 771. TRANSPORT AND PUBLIC POLICY (3)
An intensive study of the nature and consequences of relations between governments and agencies thereof, carriers in the various modes, and users of transport services. Typical areas subjected to examination and analysis include: the control of transport firms by regulatory bodies, taxation of carriers, methods employed in the allocation of funds to the construction, operation, and maintenance of publicly-provided transport facilities, and the direct subsidization of services supplied by privately-owned entities. Additional problems considered include labor and safety. Comparative international transport policies and problems are also examined.

BSAD 772. MANAGEMENT OF PHYSICAL DISTRIBUTION (3)
Focuses on managerial practices required to fulfill optimally the physical movement needs of extractive, manufacturing, and merchandising firms. Atten-

tion is given to the total cost approach to physical distribution, interrelations among purchased transport services, privately-supplied transport services, warehousing, inventory control, materials handling, packaging, and plant location are considered. An understanding of the communications network to support physical distribution is developed in conjunction with study of the problems of coordination between the physical movement management function and other functional areas within the business firm—such as accounting, finance, marketing, and production.

BSAD 773. TRANSPORTATION STRATEGIES (3)
Treats organization structure, policies, and procedures employed in the administration of inter- and intraurban transport firms. Problems receiving attention include managerial development, operational and financial planning and control, demand analysis, pricing, promotional policies, intra- and intermodal competitive and complementary relationships, and methods for accommodating public policies designed to delimit the managerial discretion of carrier executives. Administrative problems peculiar to publicly-owned and operated transport entities are also considered.

BSAD 774. PRIVATE ENTERPRISE AND PUBLIC POLICY (3)
Examines the executive's social and ethical responsibilities to his employees, customers and to the general public. Consideration is given to the conflicts occasioned by competitive relationships in the private sector of business and the effect of institutional restraints. The trends in public policy and their future effect upon management are examined. For comparative purposes, several examples of planned societies are considered.

BSAD 775. PRODUCT, PRODUCTION AND PRICING POLICY (2)
Required of M.B.A. candidates. The application of economic theory to the business enterprise in respect to the determination of policy and the handling of management problems with particular reference to the firm producing a complex line of products, nature of competition, pricing policy, interrelationship of production and marketing problems, basic types of cost, control systems, theories of depreciation and investment and the impact of each upon costs.

BSAD 777. POLICY ISSUES IN PUBLIC UTILITIES (3)
A critical analysis of current developments in regulatory policy and issues arising among public utilities, regulatory agencies, and the general public. Emphasis is placed on the electric, gas, water, and communications industries in both the public and private sectors of the economy. Changing and emerging problems stressed include those pertinent to cost analysis, depreciation, finance, taxes, rate of return, the rate base, differential rate-making, and labor. In addition, the growing importance of technolgical developments and their impact on state and federal regulatory agencies are explored.

BSAD 781. INTERNATIONAL BUSINESS ADMINISTRATION (3)
Examines the international business environment as it affects company policy and procedures. Integrates the business functions undertaken in international operations through analysis in depth and comprehensive case studies. This course can be credited toward the 18-hour requirement for a major field in the D.B.A. program.

BSAD 782. MANAGEMENT OF THE MULTINATIONAL FIRM (3)
Deals with the problems and policies of international business enterprise at the management level. Considers management of a multinational enterprise as well as management within foreign units. The multinational firm as a socio-econometric institution is analysis in detail. Cases in comparative management are utilized.

BSAD 785. MANAGEMENT PLANNING AND CONTROL SYSTEMS (3)
Concerned with planning and control systems for the fulfillment of organizational objectives. Identification of organizational objectives, responsibility centers, information needs and information network. Case studies of integrated planning and control systems.

BSAD 786. DEVELOPMENT AND TRENDS IN PRODUCTION MANAGEMENT (3)
Case studies of production problems in a number of industries. Focuses attention on decisions concerning operating programs and manufacturing policies at the top level of manufacturing. Basic concepts of process and product technology are covered. taking into consideration the scale, operating range, capital cost, method of control, and degree of mechanization at each successive state in the manufacturing process.

BSAD 787. MANAGEMENT POLICY FORMULATION (3)
An integrative course which applies students' knowledge of the various functional areas in business administration to the formulation, execution, and evaluation of managerial policies. The viewpoint of the chief administration officers and board of directors is emphasized.

BSAD 799. MASTER'S THESIS RESEARCH (1-6)

BSAD 811. ADVANCED ACCOUNTING THEORY II (3)
Prerequisite, BSAD 710. A study of the more controversial, not generally accepted ideas and concepts, currently proposed as suggested solutions to current problems or to improve the state of the art of financial accounting measurements.

BSAD 812. ACCOUNTING IN REGULATED INDUSTRIES (3)
A study of the unique accounting problems of industries subject to cost and price regulations of government agencies. Included are government contracts and grants, rate regulations for transportation carriers and public utilities, distribution cost analyses under the Robinson-Patman Act, and cost regulations of the Medicare Program.

BSAD 813. THE IMPACT OF TAXATION ON BUSINESS DECISIONS (3)
A study of the impact of tax law and regulations on alternative business strategies. Particular emphasis is given to the large, multidivisional firm. Problems of acquisitions, mergers, spinoffs, and other divesti-

tures are considered from the viewpoint of profit planning, cash flow, and tax deferment.

BSAD 814. CURRENT PROBLEMS OF PROFESSIONAL PRACTICE (3)
Generally accepted auditing standards, auditing practices, legal and ethical responsibilities, and the accounting and reporting requirements of the securities and exchange commission.

BSAD 821. MANAGERIAL ACCOUNTING II (3)
Prerequisite, BSAD 720. The management of the controllership function in the large, multidivisional firm. Centralized and decentralized organizations; management control systems in consolidated and conglomerate corporations; alternative strategies for profit maximization; acquisitions and diverstitures for increased investment return.

BSAD 828. INDEPENDENT STUDY IN BUSINESS ADMINISTRATION (1-9)

BSAD 830. MANAGEMENT SCIENCE I—LINEAR PROGRAMMING (3)
Prerequisite, mathematics, through differential calculus, and BSAD 734 or consent of instructor. The theory and use of deterministic models in management science. Models are based upon optimization techniques for conditions of data certainty. Includes linear programming models, inventory models, and replacement models.

BSAD 831. MANAGEMENT SCIENCE II—EXTENSION OF LINEAR PROGRAMMING AND NETWORK ANALYSIS (3)
Prerequisites, BSAD 830 or consent of instructor, and MATH 240. Basic Fortran programming proficiency is assumed. Includes a brief review of basic linear programming, separable programming, application to game theory, the primaldual and criss-cross algorithms, quadratic programming, basic concepts of network theory, the max-flow algorithms. The basic concepts and techniques of network theory will be developed and applied to the transportation problem.

BSAD 832. MANAGEMENT SCIENCE III—OPTIMIZATION AND NONLINEAR PROGRAMMING (3)
Prerequisites, BSAD 830 or consent of instructor, and MATH 241. Topical coverage includes Kuhn-Tucker Theory, the larrangean, the concept of an algorithm (notation map convergence), unconstrained problems, convex simplex and method of centers algorithms, penalty and barrier, feasible-directions and cutting plane algorithms.

BSAD 833. MANAGEMENT SCIENCE IV—INTEGER AND DYNAMIC PROGRAMMING (3)
Prerequisite, BSAD 831 and BSAD 832 or consent of instructor, MATH 241 minimum, MATH 400 and 410 preferred. Coverage includes fractional, all integer and mixed integer algorithms, the knapsack problem, decomposition, recursion analysis, integer optimization and sensitivity, risk and uncertainty situations and an introduction to nonserial and infinite stage systems.

BSAD 834. PROBABILISTIC MODELS (3)
Prerequisite, STAT 400 highly recommeded. MATH 241 or consent of the instructor. Theoretical foundations for the construction and optimization of probabilistic models. Following the review of stochastic processes, the Poisson process and the Markovian processes, topics may include queueing theory, inventory theory, Markovian decision processes and stochastic linear programming.

BSAD 835. STATISTICAL MODEL BUILDING (3)
Prerequisites, BSAD 432, MATH 241, or consent of instructor. Emphasizes the actual construction of models encountered in and drawn from experience in business administration utilizing 'canned' computer programs which are in wide industrial use. Topical coverage includes a review of the matrix approach to linear regression, effects of bias in the general regression situation, weighted least squares, orthogonal polynomials, vertification and maintenance of the mathematical model, and the introduction to non-linear estimation.

BSAD 840. WORKING CAPITAL MANAGEMENT (3)
An intensive study of short-and intermediate-term sources of funds and the management of cash, accounts receivable and inventories. Includes consideration of determinants of working capital needs, financial analysis as related to short-term financing problems, estimation of funds requirements, patterns of fund requirements, and major types of loan arrangements. Case studies, supplemented with outside readings.

BSAD 841. LONG-TERM CAPITAL MANAGEMENT (3)
An intensive study of long-term financing, return on investment and cost of capital. Particular attention is paid to appraising alternative forms of long-term financing, methods of measuring return on investment, and problems such as measuring the cost of capital of cyclical companies and growth companies. Case studies, supplemented with outside readings.

BSAD 843. PORTFOLIO MANAGEMENT (3)
Prerequisite, BSAD 743 or consent of instructor. The process of investment. Selection and supervision of securities appropriate for the requirements and objectives of both the individual and institutional investor. Underlying considerations necessary for the continued success of the investment program. Critical analysis of case studies in portfolio management. Effects of temporary changes on investment decisions.

BSAD 845. FINANCIAL INSTITUTIONS (3)
Provides an analysis of the structure of financial institutions in the American economy, including commercial banking and non-banking organizations which serve business and consumers. Topics covered include determinants of the demand for and supply of funds and the role of financial institutions in channeling financial capital among the various sectors of the American economy.

BSAD 846. INTERNATIONAL FINANCIAL ADMINISTRATION (3)
Deals with the problems of financial administration of the multinational firm. Includes the financing of investment abroad and management of assets in differing financial environments as well as the financing of exports and imports. Consideration of national and international financial institutions as they relate

to the international operations of American and foreign business firms.

BSAD 850. MARKETING CHANNELS ANALYSIS (3)
Focuses on the fundamentals explaining alternate channels of distribution and the roles played by various intermediaries, the evolution of business structures in marketing, reasons for change, and projected marketing patterns for the future. M.B.A. candidates may register with permission of instructor

BSAD 851. QUANTITATIVE METHODS IN MARKETING—DEMAND AND COST ANALYSIS (3)
Consideration is given to quantitative methods in the analysis and prediction of market demand and marketing costs. Topics in connection with demand include market potentials, sales forecasting, consumer analysis, promotional and pricing results, and the like. Cost analysis focuses on allocation of costs by marketing functions, products, territories, customers and marketing personnel. Statistical techniques, mathematics, models and other methods are utilized in the solution of marketing problems. M.B.A. candidates may register with permission of instructor.

BSAD 852. THEORY IN MARKETING (3)
An inquiry into the problems and elements of theory development in general with specific reference to the field of marketing. A critical analysis and evaluation of past and contemporary efforts to formulate theories of marketing and to integrate theories from the social sciences into a marketing framework. Attention is given to the development of concepts in all areas of marketing thought and to their potential application in the business firm.

BSAD 863. THE ORGANIZATION AND ITS SOCIAL ENVIRONMENT (3)
A course examining the interaction between organizations and aspects of their social and cultural environment. Analysis of the literature concerning human resource availability and individual differences as they influence managerial decisions, the impact of cultural factors on business and other types of organizations, and management approaches for dealing with the social environment.

BSAD 864. THEORY OF THE INDUSTRIAL WORK GROUP (3)
A study of major theories of group formation, group behavior, and group leadership considered in terms of their implications for the management of business and other types of organizations. Will involve an in-depth analysis of the literature concerning such topics as group cohesiveness, conformity, leadership, communication nets, problem-solving efficiency, productivity standards, and morale.

BSAD 865. COMPARATIVE THEORIES OF ORGANIZATION (3)
Emphasizes business and other types of complex organizations. Theories of formal and informal organizations are covered. Analyzes the content, interrelationships, and similarities between current major schools of organization thought.

BSAD 866. ORGANIZATIONAL CONFLICT AND CHANGE (3)
An analysis and evaluation of the factors contributing to conflict and changed patterns of behavior within organizations. A study of the literature on such topics as managerial decision making and conflict, research creativity, labor-management conflict, organizational maintenance and stability, resistance to change, and planned change.

BSAD 872. BUSINESS LOGISTICS (3)
Concentrates on the design and application of methods for the solution of advanced physical movement problems of business firms. Provides thorough coverage of a variety of analytical techniques relevant to the solution of these problems. Where appropriate, experience will be provided in the utilization of computers to assist in managerial logistical decision-making.

BSAD 873. TRANSPORTATION SCIENCE (3)
Focuses on the application of quantitative and qualitative techniques of analysis to managerial problems drawn from firms in each of the various modes of transport. Included is the application of simulation to areas such as the control of equipment selection and terminal and line operations. The application of advanced analytical techniques to problems involving resource use efficiency within the transportation industry and between transportation and other sectors of the economy is an integral part of the course.

BSAD 880. BUSINESS RESEARCH METHODOLOGY (3)
Covers the nature, scope, and application of research methodology. The identification and formulation of research designs applicable to business and related fields. Required of D.B.A. students.

BSAD 899. DOCTORAL DISSERTATION RESEARCH (1-8)

CHEMICAL ENGINEERING PROGRAM

Professor and Acting Chairman: Gomezplata
Professors: Arsenault, Beckmann, Cadman, Duffey, Goldman, Johnson, Marchello, Munno, Schroeder, Silverman, Skolnick, Smith
Associate Professors: Almenas, Bolsaitis, Gentry, Regan, Roush, Sheaks, Spain
Lecturer: Belcher

The Chemical Engineering program has as its primary objective the maintenance and extension of the ever increasing degree of engineering sophistication. The courses and research programs strive to create an atmosphere of originality and creativity that prepares the student for the engineering leadership of tomorrow.

An individual plan of graduate study compatible with the student's interest and background is established between the student, his adviser, and the department head. The general chemical engineering program is focused on five major areas: applied polymer science, biochemical engineering, environmental engineering, high pressure technology, process and analysis simulation.

The programs leading to the M.S. and Ph.D. degrees are open to qualified students holding the B.S. degree.

Admission may be granted to students with degrees in any of the engineering and science areas from accredited programs. In some cases it may be necessary to require courses to fulfill the background. The general regulations of The Graduate School apply in reviewing applications.

The candidate for the M.S. degree has the choice of following a plan of study with or without thesis. The equivalent of at least three years of full-time study beyond the B.S. degree is required for the Ph.D. degree. All students seeking graduate degrees in Chemical Engineering must enroll in ENCH 610, 620, 630, and 640. In addition to the general rules of The Graduate School certain special degree requirements are set forth by the department in its departmental publications.

A number of special facilities are available for graduate study and research and are coordinated through the Laboratory for Radiation and Polymer Science, the Laboratory for High Pressure Science, the Laboratory for Process Analysis and Simulation, the Laboratory for Biochemical Engineering and Environmental Studies, and the Nuclear Reactor Facility. These laboratories contain analog computers, a gamma radiation facility, an electron accelerator, an electron paramagnetic resonance spectrometer, high pressure and cryogenic systems, crystal growth and mechanical testing equipment, X-ray diffraction units, a neutron generator and a 200 KW pool type nuclear reactor.

ENCH 425. TRANSFER AND TRANSPORT PROCESSES I (4)
Prerequisite, ENCH 250. Theory and applications of molecular and turbulent transport phenomena. Principles of fluid mechanics, mass transfer and heat transfer. Dimensional analysis, analogy between heat mass and momentum transfer, Newtonian and non-Newtonian flow, convective heat and mass transfer.

ENCH 427. TRANSFER AND TRANSPORT PROCESSES II (3)
Prerequisite, ENCH 425. Steady and unsteady state diffusion and conduction, simultaneous heat and mass transfer, interphase transfer, boundary layer theory. Application to absorption, adsorption, and distillation. Principles of radiant heat transfer, evaporation, filtration, crystallization, drying, condensation, boiling humidification, ion exchange, and phase separations.

ENCH 437. CHEMICAL ENGINEERING LABORATORY (3)
Prerequisite, ENCH 427. Application of chemical engineering process and unit operation principles in small scale semi-commercial equipment. Data from experimental observations are used to evaluate performance and efficiency of operations. Emphasis is placed on correct presentation of results in report form.

ENCH 440. CHEMICAL ENGINEERING KINETICS (3)
Prerequisite, ENCH 250. Fundamentals of chemical reaction kinetics and their application to the design and operation of chemical reactors. Reaction rate theory, homogeneous reactions in batch and flow systems, adsorption, heterogeneous reactions and catalysis electrochemical reactions. Catalytic reactor design.

ENCH 442. CHEMICAL ENGINEERING SYSTEMS ANALYSIS (2)
Differential Equations or ENCH 453. Dynamic response applied to process systems. Goals and modes of control, Laplace transformations, analysis and synthesis of simple control systems, closed loop response, dynamic testing.

ENCH 443. DYNAMICS AND CONTROL LABORATORY (1)
Corequisite, ENCH 442. Methods of process control. Use of experimental analog and mathematical models of control systems.

ENCH 445. PROCESS ENGINEERING AND DESIGN (3)
Prerequisite, ENCH 427. Utilization of chemical engineering principles for the design of process equipment. Typical problems in the design of chemical plants. Comprehensive reports are required.

ENCH 447. CHEMICAL ENGINEERING ECONOMICS (2)
Prerequisite, ENCH 427. Principles of engineering economics applied to chemical processes. Determination of investment and operating costs for chemical plants.

ENCH 450. CHEMICAL PROCESS DEVELOPMENT (3)
Prerequisite, ENCH 427. Chemical process industries from the standpoint of technology, raw materials, products and processing equipment. Operations of major chemical processes and industries combined with quantitative analysis of process requirements and yields.

ENCH 452. ADVANCED CHEMICAL ENGINEERING ANALYSIS (3)
Prerequisite, ENCH 425. Application of digital and analog computers to chemical engineering problems. Numerical methods, programming, differential equations, curve fitting, amplifiers and analog circuits.

ENCH 453. APPLIED MATHEMATICS IN CHEMICAL ENGINEERING (3)
Prerequisite, MATH 240. Mathematical techniques applied to the analysis and solution of chemical engineering problems. Use of differentiation, integration, differential equations, partial differential equations and integral transforms. Application of infinite series, numerical and statistical methods.

ENCH 454. CHEMICAL PROCESS ANALYSIS AND OPTIMIZATION (3)
Prerequisites, ENCH 427, 440. Applications of mathematical models to the analysis and optimization of chemical processes. Models based on transport, chemical kinetics and other chemical engineering principles will be employed. Emphasis on evaluation of process alternatives.

ENCH 455. CHEMICAL PROCESS LABORATORY (2)
Prerequisites, ENCH 427, and 440. Experimental study of various chemical processes through laboratory and small semi-commercial scale equipment. Reaction kinetics, fluid mechanics, heat and mass transfer.

ENCH 461. CONTROL OF AIR POLLUTION SOURCES (3)
Prerequisite, senior standing in engineering or consent of instructor. Theory and application of methods for the control and removal of airborne materials. Principles of design and performance of air quality control equipment.

ENCH 468. RESEARCH (2-3)
Prerequisite, permission of the staff. Investigation of a research project under the direction of one of the staff members. Comprehensive reports are required.

ENCH 475. ELECTROCHEMICAL ENGINEERING (3)
Prerequisite, ENCH 425. Fundamentals of electrochemistry with application to engineering and commercial processes. Equilibrium potentials, reaction mechanisms, cell kinetics, polarization, surface phenomena. Electrorefining, electrowinning, oxidation and reduction, solid, liquid and gas systems. Aspects of design and performance of electroprocess plants.

ENCH 480. ENGINEERING ANALYSIS OF PHYSIOLOGICAL SYSTEMS (3)
Engineering description and analysis of physiological systems. Survey of bioengineering literature and an introduction to mathematical modeling of physiological systems.

ENCH 482. BIOCHEMICAL ENGINEERING (3)
Prerequisite, senior standing in Engineering or consent of instructor. Introduction to biochemical and microbiological applications to commercial and engineering processes, including industrial fermentation, enzymology, ultrafiltration, food and pharmaceutical processing and resulting waste treatment. Enzyme kinetics, cell growth, energetics and mass transfer.

ENCH 490. INTRODUCTION TO POLYMER SCIENCE (3)
Prerequisite, consent of instructor. The elements of the chemistry, physics, processing methods, and engineering applications of polymers.

ENCH 492. APPLIED PHYSICAL CHEMISTRY OF POLYMERS (3)
Prerequisite, CHEM 481. Corequisite, CHEM 482 or consent of instructor. Kinetics of formation of high polymers, determination of molecular weight and structure, and applied thermodynamics and phase equilibria of polymer solutions.

ENCH 494. POLYMER TECHNOLOGY LABORATORY (3)
One lecture and two lab periods per week. Prerequisite, ENCH 492 or consent of instructor. Measurement of mechanical, electrical, optical, and thermal properties of polymers. Measurement of molecular weight by viscosimetry, isometric and light scattering methods. Application of X-ray, NMR, ESR, spectroscopy molecular relaxation, microscopy and electron microscopy to the determination of polymer structure. Effects of ultraviolet light and high energy radiation.

ENCH 609. GRADUATE SEMINAR (1)

ENCH 610. CHEMICAL ENGINEERING THERMODYNAMICS (3)
Advanced application of the general thermodynamic methods to chemical engineering problems. First and second law consequences; estimation and correlation of thermodynamic properties; phase and chemical reaction equilibria.

ENCH 620. METHODS OF ENGINEERING ANALYSIS (3)
Application of selected mathematical techniques to the analysis and solution of engineering problems; included are the applications of matrices, vectors, tensors, differential equations, integral transforms, and probability methods to such problems as unsteady heat transfer, transient phenomena in mass transfer operations, stagewise processes, chemical reactors, process control, and nuclear reactor physics.

ENCH 630. TRANSPORT PHENOMENA (3)
Heat, mass and momentum transfer theory from the viewpoint of the basic transport equations. Steady and unsteady state; laminar and turbulent flow; boundary layer theory, mechanics of turbulent transport; with specific application to complex chemical engineering situations.

ENCH 640. ADVANCED CHEMICAL REACTION KINETICS (3)
The theory and application of chemical reaction kinetics to reactor design. Reaction rate theory; homogeneous batch and flow reactors; fundamentals of catalysis; design of heterogeneous flow reactors.

ENCH 648. SPECIAL PROBLEMS IN CHEMICAL ENGINEERING (1-6)

ENCH 655, 656. RADIATION ENGINEERING (3)
Prerequisite, permission of instructor. An analysis of such radiation applications as synthesizing chemicals, preserving foods, control of industrial processes. Design of irradiation installations, e.g., cobalt 60 gamma ray sources, electronuclear machine arrangement and chemical reactors.

ENCH 667. RADIATION EFFECTS LABORATORY (3)
Prerequisite, permission of instructor. Effect of massive doses of radiation on the properties of matter for purposes other than those pointed toward nuclear power. Radiation processing, radiation-induced chemical reactions, and conversion of radiation energy; isotype power sources.

ENCH 670. RHEOLOGY OF ENGINEERING MATERIALS (3)
Prerequisite, ENMA 650. Mechanical behavior with emphasis on the continuum point of view and its relationship to structural types. Elasticity, viscoelasticity, anelasticity and plasticity in single phase and multiphase materials.

ENCH 690. POLYMERIC ENGINEERING MATERIALS (3)
Prerequisite, ENMA 650. A comprehensive summary of the fundamentals of particular interest in the science and applications of polymers. Polymer single crystals, transformations in polymers, fabrication of polymers as to shape and internal structure.

ENCH 720. PROCESS ANALYSIS AND SIMULATION (3)
Prerequisite, ENCH 630. Development of mathemat-

ical models of chemical processes based on transport phenomena, chemical kinetics, and other chemical engineering methods. Emphasis on principles of model building and simulation utilizing mathematical solutions and computer methods.

ENCH 723. PROCESS ENGINEERING AND DESIGN (3)
Coordination of chemical engineering and economics to advanced process engineering and design. Optimization of investment and operating costs, solution of typical problems encountered in the design of chemical engineering plants.

ENCH 730. COMPLEX EQUILIBRIUM STAGE PROCESSES (3)
The theory and application of complex equilibrium stages. Binary and multicomponent absorption; extraction; liquefaction.

ENCH 735. CHEMICAL PROCESS DYNAMICS (3)
Prerequisites, differential equations or consent of instructor. Analysis of open and closed control loops and their elements; dynamic response of processes; choice of variables and linkages; dynamic testing and synthesis; noise and drift; chemical process systems analysis; strategies for optimum operation.

ENCH 737. CHEMICAL PROCESS OPTIMIZATION (3)
Techniques of modern optimization theory as applied to chemical engineering problems. Optimization of single and multivariable systems with and without constraints. Application of partial optimization techniques to complex chemical engineering processes.

ENCH 761. ENGINEERING ANALYSIS OF CIRCULATORY SYSTEM TRANSPORT (3)
Prerequisite, ENCH 480 or permission of instructor. Flow, transport phenomena, and chemical reactions involved in mammalian circulatory system function. Analysis and interpretation of tracer studies; mathematical models for simulation of transport of drugs and other solutes; internal effects of modifying environmental factors.

ENCH 762. BIOENGINEERING TRANSPORT PHENOMENA (3)
Prerequisite, ENCH 480 or permission of instructor. Engineering analysis of transport phenomena as they occur in vivo and in prosthetic devices. Survey and critique of current mathematical models for active and passive transport with emphasis on the renal and neural systems.

ENCH 763. ENGINEERING OF ARTIFICIAL ORGANS (3)
Prerequisite, ENCH 480 or permission of instructor. Design concepts and engineering analysis of devices to supplement or replace natural functions; artifiicial kidney; heart assistor; membrane oxygenator; materials problems, physiological considerations.

ENCH 784. POLYMER PHYSICS (3)
Prerequisite, ENCH 490 or consent of instructor. Application and correlation of mechanical and dielectric relaxation, NMR, electron microscopy, X-ray diffraction, diffusion and electrical properties to the mechanical properties and structure of polymers in the solid state.

ENCH 786. POLYMER PROCESSING AND APPLICATIONS (3)
Prerequisite, ENCH 490 or consent of instructor. Application of theoretical knowledge of polymers to industrial processes. An analysis of polymerization, stabilization, electrical, rheological, thermal, mechanical and optical properties and their influence on processing conditions and end use applications.

ENCH 799. MASTER'S THESIS RESEARCH (1-6)

ENCH 818. ADVANCED TOPICS IN THERMODYNAMICS (1-6)
Prerequisite, CHEM 604.

ENCH 828. ADVANCED TOPICS IN CHEMICAL REACTION SYSTEMS (3)
Prerequisite, ENCH 640.

ENCH 838. ADVANCED TOPICS IN TRANSFER THEORY (3)
Prerequisite, ENCH 720.

ENCH 848. ADVANCED TOPICS IN SEPARATION PROCESSES (3)

ENCH 899. DOCTORAL DISSERTATION RESEARCH (1-8)

CHEMISTRY PROGRAM

Professor and Chairman: Vanderslice
Professors: Breger, Castellan, Grim, Gardner,[1] Henery-Logan, Holmlund, Jaquith, Keeney,[2] Lippincott, Pickard, Pratt, Purdy, Reeve, Rollinson, Rose, Stewart, Stuntz, Veitch
Associate Professors: Ammon, Bellama, Boyd, DeVoe, Huheey, Jarvis, Kasler, Lakshmanan, Martin, Mazzocchi, Miller, Moore, O'Haver, Sampugna, Staley, Viola, Walters
Assistant Professors: Campagnoni, Hansen, Helz, Murphy, Olin, Sommer, Zoller
Research Professor: Bailey

[1] joint appointment with Secondary Education
[2] joint appointment with Dairy Science

The Chemistry Department offers programs leading to the Master of Science or Doctor of Philosophy degrees with specialization in the fields of analytical chemistry, biochemistry, chemical physics (in cooperation with the Institute for Molecular Physics and the Department of Physics and Astronomy), environmental chemistry, geochemistry, inorganic chemistry, nuclear chemistry, organic chemistry, and physical chemistry. The graduate program has been designed with maximum flexibility so that a student can achieve a strong background in his chosen field of specialization.

Departmental regulations concerning qualifying (diagnostic) examinations, comprehensive examinations, and other matters pertaining to coursework have been assembled for the guidance of candidates for graduate degrees. Copies of these regulations are available from the Department of Chemistry.

Special research facilities exist or are being developed in all the above fields, but exceptional ones

already exist for chemical physics and nuclear chemistry. The Institute for Molecular Physics laboratories have been specially designed for high-precision experiments primarily in the area of chemical physics and physical chemistry. Nuclear chemistry facilities include the 140-MeV cyclotron housed in the Physics Department. Departmental research is supported by two large computers in the Computer Science Building, an PDP 11/45 and a Univac 1108 (complemented by remote access units on a time-sharing basis). Other facilities include X-ray fluorescence instrumentation, an electron microprobe, mass spectrometers, NMR spectrometers, ultracentrifuges, and analytical optical spectrometers. Electron microscopes, ESCA spectrometers, and Laser laboratories are available through the Center of Materials Research. Individual research facilities are supported by three machine shops (two in the Institute for Molecular Physics), an excellent glassblowing shop, and electronic instrumentation personnel.

CHEM 401. INORGANIC CHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 481.

CHEM 403. RADIOCHEMISTRY (3)
Three lectures per week. Prerequisite, one year of college chemistry and one year of college physics. Radioactive decay; introduction to properties of atomic nuclei; nuclear processes in cosmology; chemical, biomedical and environmental applications of radioactivity; nuclear processes as chemical tools; interaction of radiation with matter.

CHEM 421. ADVANCED QUANTITATIVE ANALYSIS (3)
Three lectures per week. Prerequisites, CHEM 430 and 482 or concurrent registration. An examination of some advanced topics in quantitative analysis including nonaqueous titrations, precipitation phenomena, complex equilibria, and the analytical chemistry of the less familiar elements.

CHEM 423. ORGANIC QUANTITATIVE ANALYSIS (2)
Two 3-hour laboratory periods per week. Prerequisite, CHEM 203-204 or 213-214, and consent of the instructor. The semimicro determination of carbon, hydrogen, nitrogen, halogen and certain functional groups.

CHEM 430. CHEMICAL MEASUREMENTS LABORATORY I (3)
One lecture and two 3-hour laboratory periods per week. Corequisite, CHEM 481. An introduction to the principles and applications of quantitative techniques used in chemistry, with emphasis on modern instrumentation. Computer programming, electronic circuits, spectroscopy, chemical separations.

CHEM 431. CHEMICAL MEASUREMENTS LABORATORY II (3)
One lecture and two 3-hour laboratory periods per week. Prerequisite, CHEM 481; corequisite, CHEM 482. An introduction to the principles and applications of quantitative techniques useful in chemistry, with emphasis on modern instrumentation. Communications techniques, vacuum systems, thermochemistry, phase equilibria, chemical kinetics, electrochemistry.

CHEM 433. CHEMICAL SYNTHESIS (3)
One lecture and two 3-hour laboratory periods per week. Prerequisites, CHEM 201-202 or 211-212, and 203-204 or 213-214.

CHEM 441. ADVANCED ORGANIC CHEMISTRY (2)
Two lectures per week. Prerequisite, CHEM 201 or 211 and CHEM 203 or 213.

CHEM 443. QUALITATIVE ORGANIC ANALYSIS (3)
One lecture and two 3-hour laboratory periods per week. Prerequisites, CHEM 201-202 or 211-212, and 203-204 or 213-214. The systematic identification of organic compounds.

CHEM 461. BIOCHEMISTRY I (3)
Three lectures per week. Prerequisite, CHEM 203-204 or 213-214, or permission of instructor. A comprehensive introduction to general biochemistry wherein the chemistry and metabolism of carbohydrates, lipids, nucleic acids, and proteins are discussed.

CHEM 462. BIOCHEMISTRY II (3)
Three lectures per week. Prerequisite, CHEM 461. A continuation of CHEM 461.

CHEM 463. BIOCHEMISTRY LABORATORY I (2)
Two 3-hour laboratory periods per week. Prerequisite, CHEM 461 or concurrent registration in CHEM 461.

CHEM 464. BIOCHEMISTRY LABORATORY II (2)
Two 3-hour laboratory periods per week. Prerequisite, CHEM 462 or concurrent registration in CHEM 462, and CHEM 430 or CHEM 463.

CHEM 472. PRINCIPLES OF GEOCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 104 or equivalent, and senior standing. A survey of historical and modern theories of the origin of the universe and the solar system. The origin of elements and their distributions in space, on extra-terrestrial bodies and on earth. Discussion of the origin of igneous rocks, of the physical and chemical factors governing development and distribution of sedimentary rocks, of the oceans, and of the atmosphere. Organic sediments, the internal structures of earth and the planets, the role of isotopes in geothermometry and in the solution of other problems.

CHEM 473. GEOCHEMISTRY OF SOLIDS (3)
Three lectures per week. Prerequisite, CHEM 482 or GEOL 422. Principles of crystal chemistry applied to structures, properties and reactions of minerals and non-metallic solids. Emphasis is placed on the relation of structural stability to bonding, ionic size, charge, order-disorder, polymorphism, and isomorphism.

CHEM 474. ENVIRONMENTAL CHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 481, or equivalent. The sources of various elements and chemical reactions between them in the atmosphere and hydrosphere are treated. Causes and biological effects of air and water pollution by certain elements are discussed.

CHEM 475. CHEMICAL OCEANOGRAPHY (3)
Three lectures per week. Prerequisite, CHEM 103 or equivalent, and one additional semester of physical

science. An introduction to physical, chemical and geological processes that occur in the marine environment including physical and chemical properties of sea water, geology of the sea floor, general circulation of the ocean, currents, waves, and tides.

CHEM 481. PHYSICAL CHEMISTRY I (3)
Three lectures per week. Prerequisite, CHEM 203-204 or 213-214, MATH 141, PHYS 142 or PHYS 263 (PHYS 263 may be taken concurrently with CHEM 481) or consent of instructor. A course primarily for chemists and chemical engineers.

CHEM 482. PHYSICAL CHEMISTRY II (3)
Three lectures per week. Prerequisite, CHEM 481, or consent of instructor. A course primarily for chemists and chemical engineers.

CHEM 485. ADVANCED PHYSICAL CHEMISTRY (2)
Prerequisite, CHEM 482. Quantum chemistry and other selected topics.

CHEM 486. ADVANCED PHYSICAL CHEMISTRY LABORATORY (2)
Two 3-hour laboratory periods per week. Prerequisites, CHEM 482 and consent of instructor.

CHEM 498. SPECIAL TOPICS IN CHEMISTRY (3)
Three lectures or two lectures and one 3-hour laboratory per week. Prerequisite varies with the nature of the topic being considered. Course may be repeated for credit if the subject matter is substantially different, but not more than three credits may be accepted in satisfaction of major supporting area requirements for chemistry majors.

CHEM 601. ADVANCED INORGANIC CHEMISTRY (2)
Two lectures per week.

CHEM 603. ADVANCED INORGANIC LABORATORY (2)
Two 3-hour laboratory periods per week.

CHEM 604. ADVANCED INORGANIC LABORATORY (2)
Two 3-hour laboratory periods per week.

CHEM 605. CHEMISTRY OF COORDINATION COMPOUNDS (2)
Two lectures per week.

CHEM 606. CHEMISTRY OF ORGANOMETALLIC COMPOUNDS (2)
Two lectures per week.

CHEM 607. THE CHEMISTRY OF THE RARER ELEMENTS (2)
Two lectures per week.

CHEM 608. SELECTED TOPICS IN INORGANIC CHEMISTRY (2)
Two lectures a week. Prerequisite, CHEM 601, 607 or equivalent.

CHEM 621. CHEMICAL MICROSCOPY I (2)
One lecture and one 3-hour laboratory period per week. Registration limited. Prerequisite, consent of instructor. A study of the use of the microscope in chemistry.

CHEM 622. CHEMICAL MICROSCOPY II (2)
One lecture and one 3-hour laboratory period per week. Prerequisite, CHEM 621. A study of the optical properties of crystals.

CHEM 623. OPTICAL METHODS OF QUANTITATIVE ANALYSIS (3)
Two lectures and one 3-hour laboratory per week. Prerequisites, CHEM 421 and 482. The quantitative applications of emission spectroscopy, atomic absorption spectroscopy, ultraviolet, visible, and infrared spectrophotometry, fluorescence, atomic fluoresence, nephelometry, and of certain closely related subjects like NMR and mass spectroscopy.

CHEM 624. ELECTRICAL METHODS OF QUANTITATIVE ANALYSIS (3)
Two lectures and one 3-hour laboratory per week. Prerequisites, CHEM 421 and 482. The use of conductivity, potentiometry, polarography, voltammetry, amperometry, coulometry, and chronopotentiometry in quantitative analysis.

CHEM 625. SEPARATION METHODS IN QUANTITATIVE ANALYSIS (3)
Two lectures and one 3-hour laboratory per week. Prerequisites, CHEM 421 and 482. The theory and practical application to quantitative analysis of the various forms of chromatography, ion exchange, solvent extraction, and distillation.

CHEM 628. MODERN TRENDS IN ANALYTICAL CHEMISTRY (2)
Two lectures per week. Prerequisites, CHEM 421 and 482. A study of advanced methods, including topics such as statistical treatment of analytical data, kinetic methods in analytical chemistry, analytical measurements based on radioactivity, and enzymatic techniques.

CHEM 641. ORGANIC REACTION MECHANISMS (3)
Three lectures per week.

CHEM 642. PHYSICAL ORGANIC CHEMISTRY (3)
Three lectures per week.

CHEM 643. ORGANIC CHEMISTRY OF HIGH POLYMERS (2)
Two lectures per week. An advanced course covering the synthesis of monomers, mechanisms of polymerization, and the correlation between structure and properties in high polymers.

CHEM 644. MOLECULAR ORBITAL THEORY (2)
Two lectures per week. A partial quantitative application of molecular orbital theory and symmetry to the chemical properties and reactions of organic molecules. Prerequisites, CHEM 441 and 482.

CHEM 645. THE CHEMISTRY OF THE STEROIDS (2)
Two lectures per week.

CHEM 646. THE HETEROCYCLICS (2)
Two lectures per week.

CHEM 648. SPECIAL TOPICS IN ORGANIC CHEMISTRY (2)
Two lectures per week.

CHEM 661. PROTEINS, AMINO ACIDS, AND CARBOHYDRATES (2)
Two lectures per week. Prerequisite, CHEM 462 or equivalent.

CHEM 662. BIOLOGICAL ENERGY TRANSDUCTIONS, VITAMINS, AND HORMONES (2)
Two lectures per week. Prerequisite, CHEM 462 or equivalent.

CHEM 663. ENZYMES (2)
Two lectures per week. Prerequisite, CHEM 462 or equivalent.

CHEM 664. THE CHEMISTRY OF NATURAL PRODUCTS (2)
Two lectures per week. Prerequisite, CHEM 441. The chemistry and physiological action of natural products. Methods of isolation, determination of structure and synthesis.

CHEM 665. BIOCHEMISTRY OF LIPIDS (2)
Two lectures per week. Prerequisite, CHEM 462 or equivalent. Classification and chemistry of lipids, lipogenesis and energy metabolism of lipids, structural lipids, and endocrine control of lipid metabolism in mammals.

CHEM 666. BIOPHYSICAL CHEMISTRY (2)
Two lectures per week. Prerequisite, CHEM 461 and 482, or consent of instructor.

CHEM 668. SPECIAL PROBLEMS IN BIOCHEMISTRY (2-4)
Two to four 3-hour laboratory periods per week. Prerequisite, CHEM 464 or equivalent.

CHEM 669. SPECIAL TOPICS IN BIOCHEMISTRY (2)
Two lectures per week. Prerequisite, CHEM 462 or equivalent.

CHEM 681. INFRA-RED AND RAMAN SPECTROSCOPY (2)
Two lectures per week. Prerequisite, consent of instructor.

CHEM 682. REACTION KINETICS (3)
Three lectures per week.

CHEM 683. ELECTROCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 684 or equivalent.

CHEM 684. CHEMICAL THERMODYNAMICS (3)
Three lectures per week. Prerequisite, CHEM 482 or equivalent.

CHEM 685. MOLECULAR STRUCTURE (3)
Three lectures per week.

CHEM 686. CHEMICAL CRYSTALLOGRAPHY (3)
Three lectures per week. Prerequisite, consent of instructor. A detailed treatment of single-crystal x-ray methods.

CHEM 687. STATISTICAL MECHANICS AND CHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 684 or equivalent.

CHEM 688. SELECTED TOPICS IN PHYSICAL CHEMISTRY (2)
Two lectures per week.

CHEM 689. SPECIAL TOPICS IN PHYSICAL CHEMISTRY (3)
Three lectures per week.

CHEM 690. QUANTUM CHEMISTRY I (3)
Three lectures per week. Prerequisite, CHEM 485.

CHEM 691. QUANTUM CHEMISTRY II (3)
Three lectures per week. Prerequisite, CHEM 690 or PHYS 622.

CHEM 702. RADIOCHEMISTRY LABORATORY (1-2)
One or two 4-hour laboratory periods per week. Registration limited. Prerequisites, CHEM 403 (or concurrent registration therein), and consent of instructor.

CHEM 703. ADVANCED RADIOCHEMISTRY (2)
Two lectures per week. Prerequisite, CHEM 403 and 462. Utilization of radioisotopes with special emphasis on applications to problems in the life sciences.

CHEM 704. ADVANCED RADIOCHEMISTRY LABORATORY (1-2)
One or two 4-hour laboratory periods per week. Prerequsite, CHEM 702 and consent of instructor. Laboratory training in the utilization of radioisotopes with special emphasis on applications to problems in the life sciences.

CHEM 705. NUCLEAR CHEMISTRY (2)
Two lectures per week. Prerequisite, CHEM 482. An introduction to nuclear chemistry. The more important nuclear decay phenomena; nuclear models; nuclear spin; reactions in complex nuclei; interactions of radiation with matter. Emphasis is placed on the behavior of heavy elements and nuclear systematics.

CHEM 718. SPECIAL TOPICS IN NUCLEAR CHEMISTRY (1-3)
One to three lectures per week. A discussion of current research problems. Subtitles will be given at each offering. Repeatable for credit to a maximum of six hours.

CHEM 721. ORGANIC GEOCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 201 or equivalent. A discussion of the fate of natural organic products in the geological environment. The influence of diagenetic factors, such as hydrolysis, heat, pressure, etc., on such compounds as cellulose, lignin, proteins, and lipids, detailed consideration of the origin of soil organic matter, carbonaceous shales, coal, and crude oil.

CHEM 722. COSMOCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 482 or equivalent. Current theories of origin and evolution of the solar system with emphasis on the experimental data available to chemists from examination of meteorites, the moon, and the earth.

CHEM 723. MARINE GEOCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 481 or equivalent. The geochemical evolution of the ocean; composition of sea water, density-chlorinity-salinity relationship and carbon dioxide system. The geochemistry of sedimentation with emphasis on the chemical stability and inorganic and biological production of carbonate, silicate and phosphate containing minerals.

CHEM 728. SELECTED TOPICS IN ANALYTICAL GEOCHEMISTRY (2-3)
One or two lectures per week and one laboratory per week. Prerequisite, consent of instructor. This course will be subtitled each time it is offered to indicate the analytical method discussed. Repeatable for credit to a maximum of nine hours. Enrollment will be limited.

CHEM 729. SPECIAL TOPICS IN GEOCHEMISTRY (1-3)
One to three lectures per week. A discussion of current research problems. Subtitles will be given at each offering. Repeatable for credit to a maximum of six hours.

CHEM 799. MASTER'S THESIS RESEARCH (1-6)

CHEM 898. SEMINAR (1)

CHEM 899. DOCTORAL DISSERTATION RESEARCH (1-8)

CIVIL ENGINEERING PROGRAM

Professor and Chairman: Carter
Professors: Lepper, Otts, Ragan
Associate Professors: Birkner, Colville, Cookson, Cournyn, Hall, Heins, Israel,[1] Piper, Sternberg, Wedding
Assistant Professor: McCuen
[1] joint appointment with Meteorology

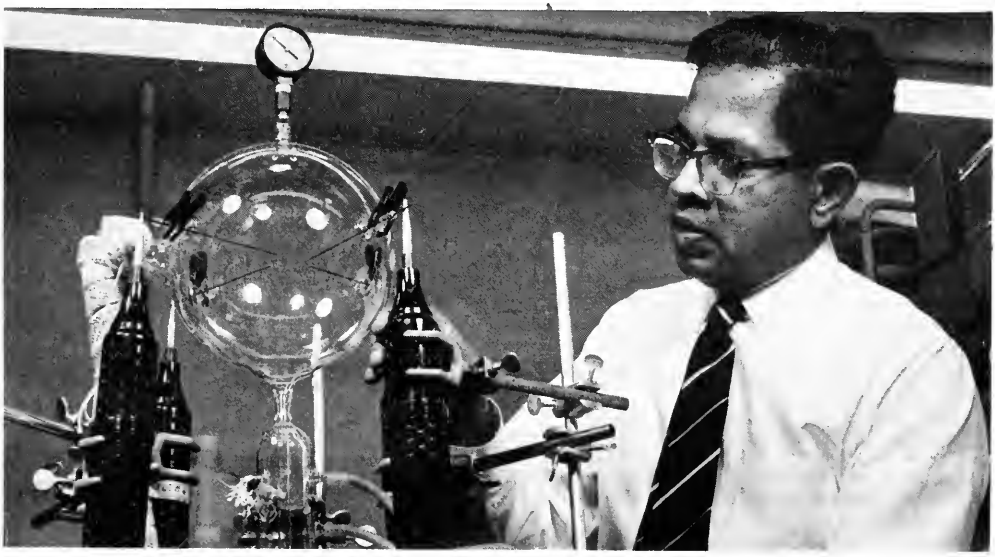
The Department of Civil Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Courses and research opportunities are available in the general areas of transportation and urban systems, environmental and water resources, and structural engineering. All programs are planned on an individual basis to consider the student's background and his special interests. Emphasis is on the use of sound engineering methodology for the solution of the physical problems of man's environment.

ENCE 400. ADVANCED MATERIALS OF ENGINEERING (3)
Three lectures per week. Prerequisite, ENCE 300. Mechanisms of the behavior of materials under repeated, sustained and impact loads in relation to their environment. Influence of microstructure on mechanical properties. Fracture theory rheological aspects of the characteristics of selected materials.

ENCE 410. ADVANCED STRENGTH OF MATERIALS (3)
Three lectures per week. Prerequisite, ENES 220. Strength and deformation of deformable bodies, plane stress and strain. Torsion theory, unsymmetrical bending, curved beams. Behavior of beams, columns, slabs, plates and composite members unload. Elastic and inelastic stability.

ENCE 411. EXPERIMENTAL STRESS ANALYSIS (4)
Three lectures and one laboratory per week. Prerequisite, ENES 220. Application of experimental data on materials to design problems. Correlation of analytical and experimental methods of analysis with design. Electric strain gages, photoelasticity, brittle laquer methods and various analogies.

ENCE 420. BASIC CIVIL ENGINEERING PLANNING I (2)
Two lectures per week. Prerequisites or corequisites,



ELECTRICAL DISCHARGE APPARATUS SIMULATING LIGHTNING IN A PRIMITIVE ATMOSPHERE
Department of Chemistry

ENCE 340, 351, and 370. Lectures in the methodology used in the general practice of civil engineering but with special emphasis on planning of extensive civil engineering works. In addition, preparation of engineering reports, specifications and projects presentation, economics, functional aspects.

ENCE 421. BASIC CIVIL ENGINEERING PLANNING II (1)
One laboratory of three hours per week. Prerequisite, ENCE 420. Laboratory for application of the program and principles developed in Basic Civil Engineering Planning I.

ENCE 430. INTERMEDIATE FLUID MECHANICS (4)
Three lectures and one laboratory per week. Prerequisite, ENCE 330. The study of the properties and flow of an ideal fluid. (Viscosity, laminar and turbulent flow, flow nets, uniform flow, source, irrotational motion and circulation.) Turbulence and boundary layers.

ENCE 431. SURFACE WATER HYDROLOGY (3)
Prerequisites, ENCE 330 and 360. Concurrent registration in ENCE 460 or permission of instructor. Study of the physical processes of the hydrologic cycle, hydrometeorology, concepts of hydrometeorology, concepts of weather modification, evaporation and transpiration infiltration studies, run off computations, flood routing, reservoir requirements, emphasis on process simulation as a tool in water resource development.

ENCE 432. GROUND WATER HYDROLOGY (3)
Prerequisites, ENCE 330, 460 or permission of instructor. Concepts related to the development of the ground water resource, hydrogeology, hydrodynamics of flow through porous media, hydraulics of wells, artificial recharge, sea water intrusion, basin-wide ground water development.

ENCE 433. ENVIRONMENTAL ENGINEERING ANALYSIS (3)
Two lectures and one laboratory per week. The theory and analytical techniques used in evaluating man's environment. Emphasis is given to the areas of quantitative, physical, electroanalytical and organic chemistry as applied to chemical analysis of water.

ENCE 434. AIR POLLUTION (3)
Three lectures per week. Classification of atmospheric pollutants and their effects on visibility, inanimate and animate receptors. Evaluation of source emissions and principles of air pollution control; meteorological factors governing the distribution and removal of air pollutants; air quality measurements and air pollution control legislation.

ENCE 435. SANITARY ENGINEERING ANALYSIS AND DESIGN (4)
Three lectures and one laboratory per week. Prerequisite, ENCE 221. The application of sanitary analysis and fundamental principles to the design and operation of water and waste treatment plants and the control of stream pollution.

ENCE 440. ADVANCED SOIL MECHANICS (4)
Three lectures and one laboratory per week. Prerequisite, ENCE 340. Theories of strength, compressibility, capillarity and permeability. Critical review of theories and methods of measuring essenttial properties. Planning, execution and interpretation of soil testing programs.

ENCE 441. SOIL-FOUNDATION SYSTEMS (3)
Three lectures per week. Prerequisite, ENCE 340. Soil mechanics and foundation analysis are integrated in a systems approach to the analysis and design of soil foundation-structural systems. Interaction of bearing capacity, settlements, lateral pressures, drainage, vibrations, stress distributions, etc., are included for a variety of structural systems.

ENCE 450. STRUCTURAL ANALYSIS (3)
Three lectures per week. Prerequisite, ENCE 351. Advanced indeterminate structures, members of variable section, laterally loaded frames, continuous trusses and secondary stresses.

ENCE 451. STRUCTURAL DESIGN (4)
Three lectures and one laboratory per week. Prerequisite, ENCE 351. Steel and reinforced concrete design of bridges and buildings using appropriate controlling specifications. Advanced problems of modern steel and reinforced concrete.

ENCE 460. COMPUTER ANALYSIS (3)
Two lectures and one laboratory per week. Prerequisites, ENCE 360 and 350. Computer methods and techniques applied to civil engineering problems with emphasis on structural systems.

ENCE 461. ANALYSIS OF CIVIL ENGINEERING SYSTEMS I (3)
Prerequisite, senior standing or consent of instructor. Application of the program and principles developed in basic civil engineering problems. Economic comparison of alternatives using present worth, annual cost, rate of return and cost benefit analysis. Development and use of simple and multiple regression models and statistical · decision theory.

ENCE 470. HIGHWAY ENGINEERING (3)
Three lectures per week. Prerequisite, ENCE 340. Location, design, construction and maintenance of roads and pavements. Introduction to traffic engineering.

ENCE 471. TRANSPORTATION ENGINEERING (3)
Three lectures per week. Prerequisite, ENCE 370. A study of the principles of transportation engineering as applied to the various modes of transport. Consideration is given to cost analysis, economic aspects of route and site selection and layout. The organization and administration of engineering functions.

ENCE 472. HIGHWAY AND AIRFIELD PAVEMENT DESIGN (3)
Prerequisites, ENCE 340, 370, and 470 or equivalent. Two lectures and one laboratory per week Principles of pavement analysis and design. Analysis of moving loads and pavement response. Subgrade evaluation and benefication. Flexible and rigid pavement design; related materials specifications and tests.

ENCE 489. SPECIAL PROBLEMS (3)
Prerequisite, senior standing. A course arranged to meet the needs of exceptionally well prepared stu-

dents for study in a particular field of civil engineering.

ENCE 600. ADVANCED ENGINEERING MATERIALS LABORATORY (3)
Prerequisites, ENES 220, 221 and ENCE 330 or equivalent. Critical examination of the methods for testing engineering materials and structures under static, repeated, sustained and impact forces. Laboratory experiments for the determination of strength and stiffness of structural alloys, concrete and other construction materials. Critical examination of the effects of test factors on the determination of engineering properties.

ENCE 601. STRUCTURAL MATERIALS AND DESIGN (3)
Prerequisite, ENCE 410 and 411 or consent of instructor. Relation of structural analysis, properties of materials and laboratory study of the behavior of members to structural design methods, codes and specifications. Effects of temperature, loading rates and state of combined stress on behavior of construction materials.

ENCE 603. THEORIES OF CONCRETE AND GRANULAR MATERIALS (3)
Prerequisites, ENCE 600, or consent of instructor, critical reviews of analytical and experimental investigations of the behavior of concretes under diverse conditions of loading and environment. Mechanics of granular aggregates and the chemistry of cements. Theories of the design of Portland cement and field experience.

ENCE 610. ADVANCED STRENGTH OF MATERIALS (3)
Prerequisites, ENES 220, 221 and ENCE 300, or equivalent. Analysis for stress and deformation in engineering members by the methods of mechanics of materials and elementary theories of elasticity and plasticity. Problems in flexure, torsion plates and shells, stress concentrations, indeterminate combinations, residual stresses, stability.

ENCE 612. STRUCTURES RESEARCH METHODS AND MODEL ANALYSIS (3)
Prerequisites, ENCE 450 and ENCE 451 or equivalent. Instrumentation, data analysis; states of stress; structural models, structural similitude, analogies; non-destructive testing techniques; planning research proects, lab studies and reports.

ENCE 620. URBAN-REGIONAL CIVIL ENGINEERING PLANNING (3)
Prerequisite, degree in civil engineering or consent of instructor. Theory and methodology for the synthesis of general civil engineering aspects of urban and regional planning. Integration of land use conditions and capabilities, population factors and needs, engineering economics and engineering technologies, application to special problems in urban-regional development. Preparation of engineering reports. Presentation methods.

ENCE 621. CIVIL ENGINEERING PLANNING (3)
Prerequisite, ENCE 620 or equivalent. General to comprehensive planning of complex engineering facilities such as industrial plants, bridges, utilities and transportation projects. Planning based on the synthesis of all applicable factors. Emphasis on general civil engineering planning, including site, structural and construction planning. Plan evaluation and feasibility.

ENCE 622. URBAN AND REGIONAL SYSTEMS ANALYSIS (3)
Prerequisite or corequisite, ENCE 461 or consent of instructor. Current applications and research approaches in land-use forecasting, land-use evaluation, urban transportation, land-use interrelationships, and the planning implementation process in a systems analytic framework.

ENCE 630. ANALYSIS AND DESIGN OF WATER RESOURCE SYSTEMS (3)
Prerequisite, ENCE 461 or equivalent. Use of advanced techniques for the design and analysis of complex, multi-purpose water resource systems; identification of the objectives of design and translation of the objectives into design criteria; evaluation of alternate designs and the selection of the best design; special emphasis on optimization and simulation techniques which are applicable to water resource systems.

ENCE 631. ADVANCED HYDROLOGIC ANALYSIS (3)
Emphasis is on the analysis of hydrologic data for the development of information necessary for design or for the identification of important processes; eigenvalue and eigenvector analysis of linear hydrologic systems; application of multivariant statistical methods; non-linear least squares.

ENCE 632. FREE SURFACE FLOW (3)
Prerequisite, ENCE 330 or equivalent. Application of fundamentals of fluid mechanics to problems of free surface flow; computation of steady and transient water surface profiles; stratified flows in reservoirs and estuaries; diffusion; transition structures; sediment transport.

ENCE 633. THE CHEMISTRY OF NATURAL WATERS (4)
Prerequisite, ENCE 433 or consent of instructor. Three lectures, one lab a week. Application of principles from chemical thermodynamics and kinetics to the study and interpretation of the chemical composition of natural waters is rationalized by considering metal ion soluability controls, ph, carbonate equilibria, absorption reactions, redox reactions, and the kinetics of oxygenation reactions which occur in natural water environments.

ENCE 634. AIR SAMPLING AND ANALYSIS (3)
Prerequisite. ENCE 434 or consent of instructor. Two lectures and one laboratory a week. The theory and techniques used in the determination and measurement of chemical, radiological, and biological pollutants in the atmosphere. Discussion of air sampling equipment, analytical methods and data evaluation.

ENCE 635. DESIGN OF WATER PURIFICATION FACILITIES (3)
Corequisite, ENCE 636 or equivalent. One lecture and two laboratory periods a week. Application of basic science and engineering science to design of water supply and purification processes; design and economics of unit operations as applied to environmental systems.

ENCE 636. UNIT OPERATIONS OF ENVIRONMENTAL ENGINEERING (3)
Prerequisite, ENCE 221 or consent of instructor. Properties and quality criteria of drinking water as related to health are interpreted by a chemical and biological approach. Legal aspects of water use and handling are considered. Theory and application of aeration, sedimentation, filtration, centrifugation, desalinization, corrosion and corrosion control are among topics to be considered.

ENCE 637. BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING (4)
Prerequisite, MICB 440 or equivalent. Three lectures and one lab period a week. An exposition of biological principles directly affecting man and his environment; assay, control and treatment of biological and virological agents in water, sewage, and air; microbiology and biochemistry of aerobic and anaerobic treatment processes for aqueous wastes.

ENCE 640. SOIL MECHANICS (3)
Prerequisites, ENCE 340, 440 or equivalent. Identification properties tests and classification methods for earth materials. Strength and deformation characteristics, hydraulic properties and permeability, shearing reistance, compressibility and consolidation, with laboratory tests for these properties. Study of the basic theories involved and the development of test procedures.

ENCE 641. ADVANCED FOUNDATIONS (3)
Prerequisites, ENCE 340, 450 and 451 or equivalent. Principles of mechanics applied to engineering problems in foundation. Earth pressure theories, seepage and drainage phenomena, stability of footings and slopes, stresses and deformation in soils, consolidation theory and application to foundation settlements.

ENCE 651. MATRIX METHODS OF STRUCTURAL ANALYSIS (3)
Review of basic structural and matrix theory. Development of force and displacement methods with emphasis on the latter. Discussion of special topics such as geometric nonlinearity, automated and optimum design nonprismatic members and thin-walled open sections and sub-division of large structures. Emphasis on applications to civil engineering structures.

ENCE 652. ANALYSIS OF PLATE AND SHELL STRUCTURES (3)
Prerequisites, ENCE 410 and ENCE 381 or equivalent. Review of theory of elasticity and in-plane forces; theory of orthotropic plates; approximate methods; large deflection theory, buckling; general theory of shells, cylindrical shells, domes.

ENCE 655. PLASTIC ANALYSIS AND DESIGN OF STRUCTURES (3)
Prerequisite, permission of instructor. The study of the factors affecting the plastic behavior of steel structures and the criteria necessary for design. The design of beams, rigid frames and multi-story braced frames using current specifications. A review of current research and practice.

ENCE 656. ADVANCED STEEL DESIGN (3)
Prerequisite, ENCE 450 and 451 or equivalent. Interpretation of specifications and codes for the design of steel buildings and bridges. Discussion of the behavior of steel connections, members and structures; the relationship between behavior and design specifications.

ENCE 657. THEORY OF STRUCTURAL DESIGN (3)
Prerequisite, ENCE 656. Correlation of theory, experience, and experiments in study of structural behavior, proportioning, and preliminary design. Special design problems of fatigue, buckling, vibrations, and impact.

ENCE 660. ENGINEERING ANALYSIS (3)

ENCE 661. FINITE ELEMENT TECHNIQUES IN ENGINEERING ANALYSIS (3)
Prerequisite, consent of instructor. Basic principles and fundamental concepts of the finite element method. Consideration of geometric and material nonlinearities, convergence, mesh gradation and computational procedures in analysis. Applications to plane stress and plane strain, plates and shells, eigenvalue problems, axi-symmetric stress analysis, and other problems in civil engineering.

ENCE 670. HIGHWAY TRAFFIC CHARACTERISTICS AND MEASUREMENTS (3)
Prerequisite, ENCE 470 or consent of instructor. The study of the fundamental traits and behavior patterns of the road user and his vehicle in traffic. The basic characteristics of pedestrian, the driver, the vehicle, traffic volume and speed, stream flow and intersection operation, parking, and accidents.

ENCE 671. HIGHWAY TRAFFIC OPERATIONS (3)
Prerequisite, ENCE 470, ENCE 670 or consent of instructor. A survey of traffic laws and ordinances. The design, application and operation of traffic control devices and aids, including traffic signs and signals, pavement markings, and hazard delineation. Capacity, accident, and marking analyses.

ENCE 672. REGIONAL TRANSPORTATION PLANNING (3)
Prerequisite, ENCE 471 or consent of instructor. Factors involved and the components of the process for planning, statewide and regional transportation systems, encompassing all models. Transportation planning studies, statewide traffic models, investment models, programming and scheduling.

ENCE 673. URBAN TRANSPORTATION PLANNING (3)
Prerequisite, ENCE 672 or consent of instructor. Relationship of transportation to the total urban complex, the urban transportation planning process, the models used to achieve the various steps in the process and the relationship of private and public transportation. Consideration of the factors influencing the demand for transportation and the socioeconomic consequences of transportation.

ENCE 674. URBAN TRANSIT PLANNING AND RAIL TRANSPORTATION ENGINEERING (3)
Prerequisite, ENCE 471 or consent of instructor. Basic engineering components of conventional and high speed railroads and of air cushion and other high speed new technology. The study of urban rail and bus transit. The characteristics of the vehicle, the supporting way, and the terminal requirements

will be evaluated with respect to system performance, capacity, cost, and level of service.

ENCE 675. AIRPORT PLANNING AND DESIGN (3)
Prerequisite, ENCE 471 or consent of instructor. The planning and design of airports including site selection, runway configuration, geometric and structural design of the landing area, and terminal facilities. Methods of financing airports, estimates of aeronautical demand, air traffic control and airport lighting are also studied.

ENCE 676. HIGHWAY TRAFFIC FLOW THEORY (3)
Prerequisite, ENCE 461, ENCE 462 or consent of the instructor. An examination of physical and statistical laws that are used to represent traffic flow phenomena. Deterministic models including heat flow, fluid flow, and energy-momentum analogies, car following models, and acceleration noise. Stochastic approaches using independent and Markov processes, queuing models, and probability distributions.

ENCE 677. QUANTITATIVE METHODS IN TRANSPORTATION ENGINEERING (3)
Prerequisite, ENCE 461 or consent of instructor. Theory, methods and applications relevant to the study of micro and macro-scale transportation systems, in terms of their behavior, design, and evaluation. A selected overview of optimization, multivariate statistics, stochastic processes and the general science of systems decision processes will form the basis for a selected study of pertinent examples.

ENCE 688. ADVANCED TOPICS IN CIVIL ENGINEERING (1-3)
Prerequisite, permission of instructor. Advanced topics selected by the faculty from the current literature of civil engineering to suit the needs and background of students. May be taken for repeated credit when identified by topic title.

ENCE 689. SEMINAR (1-16)

ENCE 731. ADVANCED GROUND WATER HYDROLOGY (3)
Prerequisite, ENCE 432 or equivalent. Theory and application of unsteady flow in porous media. Analysis of one and two dimensional unsteady flow. Solutions of non-linear equation of unsteady flow with a free surface. Development and use of approximate numerical and graphical methods in the study of ground water movement.

ENCE 732. DETERMINISTIC MODELS IN SURFACE WATER HYDROLOGY (3)
A detailed examination of the processes controlling the quantity and quality of watershed runoff: emphasis is on the development of deterministic mathematical models for process simulation; role of land-phase processes in flood hydrology; evaporation and transpiration; models for urban watersheds; linkage for hydrograph synthesis.

ENCE 733. APPLIED WATER CHEMISTRY (4)
Prerequisite, ENCE 633 or consent of instructor. Three lectures, one lab a week. A study of the chemistry of both municipal and industrial water treatment processes. Among the topics to be considered are water softening, stabilization, chemical destabilization of colloidal materials, ion exchange, disinfection, chemical oxidation and oxygenation reactions.

ENCE 734. AEROSOL SCIENCE AND TECHNOLOGY (3)
Three lectures per week. Prerequisite, ENCE 430 or equivalent. Physical properties of air-borne particles. Theories of: particle motion under the action of external forces; coagulation; Brownian motion and diffusion. Application of aerosols in atmospheric sciences and industrial processes.

ENCE 735. DESIGN OF MUNICIPAL AND INDUSTRIAL WASTES TREATMENT FACILITIES (3)
Corequisite, ENCE 736 or equivalent. One lecture and two laboratory periods a week. Application of basic science and engineering science to design of municipal and industrial waste treatment processes; design and economics of unit operations as applied to environmental systems.

ENCE 736. THEORY OF AQUEOUS AND SOLID WASTE TREATMENT AND DISPOSAL (3)
Prerequisites, ENCE 221 and fundamentals of microbiology, or consent of instructor. Theory and basic principles of treating and handling waste products; hydraulics of sewers; biological oxidation; principles and design criteria of biological and physical treatment processes; disposal of waste sludges and solids.

ENCE 737. INDUSTRIAL WASTES (3)
Corequisite, ENCE 736 or equivalent. A study of the characteristics of liquid wastes from major industries, and the processes producing the wastes. The theory and methods of eliminating or treating the wastes, and their effects upon municipal sewage-treatment plants, and receiving waters.

ENCE 738. SELECTED TOPICS IN POROUS MEDIA FLOW (3)
Prerequisite, ENCE 731. Analysis of two-liquid flows for immiscible fluids, simultaneous flow of two immiscible fluids and miscible fluids. Hydrodynamic dispersion theories, parameters of dispersion and solutions of some dispersion problems with emphasis on migration of pollutants. A maximum of six hours may be earned in this course.

ENCE 750. ANALYSIS AND DESIGN OF STRUCTURAL SYSTEMS (3)
Prerequisite, ENCE 450 and ENCE 451 or equivalent Review of classical determinate and indeterminate analysis techniques; numerical technique; multistory buildings; space structures; suspension bridges and cables structures; arches; long span bridges.

ENCE 751. ADVANCED PROBLEMS IN STRUCTURAL BEHAVIOR (3)
Prerequisite, ENCE 750 or equivalent. Elastic and inelastic behavior of structural members and frames; problems in torsion, stability and bending; open and closed thin-walled sections; curved girders.

ENCE 753. REINFORCED CONCRETE STRUCTURES (3)
Prerequisite, ENCE 450 and 451 or equivalent. The behavior and strength of reinforced concrete members under combined loadings, including the effects of creep, shrinkage and temperature. Mechanisms

of shear resistance and design procedures for bond, shear and diagonal tension. Elastic and ultimate strength analysis and design of slabs. Columns in multistory frames. Applications to reinforced concrete structures.

ENCE 754. PRESTRESSED CONCRETE STRUCTURES (3)
Prerequisite, ENCE 450 and 451 or equivalent. Fundamental concepts of prestressed concrete. Analysis and design of flexural members including composite and continuous beams with emphasis on load balancing technique. Ultimate strength design for shear. Design of post tensioned flat slabs. Various applications of prestressing including tension members, compression members, circular prestressing, frames and folded plates.

ENCE 799. MASTER'S THESIS RESEARCH (1-6)

ENCE 899. DOCTORAL DISSERTATION RESEARCH (1-8)

CLASSICAL LANGUAGES AND LITERATURES COURSES

GREEK

Prerequisite for 400-level courses; the status of advanced undergraduate or graduate and consent of the instructor.

GREK 401. THUCYDIDES (3)

GREK 402. GREEK PHILOSOPHERS (3)

GREK 403. GREEK TRAGEDY (3)

GREK 404. GREEK COMEDY (3)

GREK 405. GREEK ORATORY (3)

GREK 406. GREEK EPIGRAPHY (3)

GREK 499. GREEK READINGS (3)
Prerequisite, consent of the instructor. The reading of one or more selected Greek authors. Reports. May be repeated with different content.

LATIN

Prerequisite for 400-level courses, LATN 361.

LATN 401. CATULLUS AND THE ROMAN ELEGIAC POETS (3)

LATN 402. TACITUS (3)

LATN 403. ROMAN SATIRE (3)

LATN 404. ROMAN COMEDY (3)

LATN 405. LUCRETIUS (3)

LATN 411. ADVANCED LATIN GRAMMAR (3)
Prerequisite, three years of college Latin or equivalent. An intensive study of the morphology and syntax of the Latin language supplemented by rapid reading.

LATN 499. LATIN READINGS (3)
Prerequisite, consent of instructor. The reading of one or more selected Latin authors from antiquity through the Renaissance. Reports. May be repeated with different content.

LATN 610. VULGAR LATIN READINGS (3)
Prerequisite, consent of instructor. An intensive review of the phonology, morphology, and syntax of Classical Latin, followed by the study of the deviations of Vulgar Latin from the classical norms, with the reading of illustrative texts. The reading of selections from the *Peregrinatio ad loca sancta* and the study of divergences from classical usage therein, with special emphasis on those which anticipate subsequent developments in the Romance Languages. Reports. (Avery)

COMPARATIVE LITERATURE PROGRAM

Professor and Acting Chairman: Russell (English)
Professors: Levitine (Art); Freedman, Whittemore (English); Jones (Germanic and Slavic); Goodwyn (Spanish and Portuguese); Perloff, Salamanca (English).
Associate Professor: Greenwood
Assistant Professors: Swigger (English); Lebreton-Savigny, Salchenberger (French and Italian).

The Program in Comparative Literature offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Current language, course, examination, Master of Arts thesis, and Doctor of Philosophy dissertation requirements for graduate degrees in Comparative Literature may be obtained from the departmental office.

Departments cooperating in the program are Art, Classical Languages, English, Germanic and Slavic Languages and Literature, French and Italian Languages and Literature, and the program in Hebrew, Chinese, and Linguistics.

CMLT 401. INTRODUCTORY SURVEY OF COMPARATIVE LITERATURE (3)
Survey of the background of European literature through study of Greek and Latin literature in English translations, discussing the debt of modern literature to the ancients. (Greenwood)

CMLT 402. INTRODUCTORY SURVEY OF COMPARATIVE LITERATURE (3)
Study of the medieval and modern continental literature. (Greenwood)

CMLT 411. THE GREEK DRAMA (3)
The chief works of Aeschylus, Sophocles, Euripides, and Aristophanes in English translations. Emphasis on the historic background, on dramatic structure, and on the effect of the attic drama upon the mind of the civilized world.

CMLT 415. THE OLD TESTAMENT AS LITERATURE (3)
A study of sources, development and literary types. (Greenwood)

CMLT 416. NEW TESTAMENT AS LITERATURE (3)
A study of the books of the New Testament, with attention to the relevant historical background and to the transmission of the text. A knowledge of Greek is helpful, but not essential. (Greenwood)

CMLT 421. THE CLASSICAL TRADITION AND ITS INFLUENCE IN THE MIDDLE AGES AND THE RENAISSANCE (3)
Emphasis on major writers. Reading knowledge of Greek or Latin required. (Greenwood)

CMLT 422. THE CLASSICAL TRADITION AND ITS INFLUENCE IN THE MIDDLE AGES AND THE RENAISSANCE (3)
Emphasis on major writers. Reading knowledge of Greek or Latin required. (Greenwood)

CMLT 430. LITERATURE OF THE MIDDLE AGES (3)
Narrative, dramatic and lyric literature of the Middle Ages studied in translation. (Jones)

CMLT 433. DANTE AND THE ROMANCE TRADITION (3)
A reading of the Divine Comedy to enlighten the discovery of reality in western literature. (Salchenberger)

CMLT 461. ROMANTICISM—EARLY STAGES (3)
Emphasis on England, France and Germany. Reading knowledge of French or German required. (Swigger)

CMLT 462. ROMANTICISM—FLOWERING AND INFLUENCE (3)
Emphasis on England, France and Germany. Reading knowledge of French or German required.

CMLT 469. THE CONTINENTAL NOVEL (3)
The novel in translation from Stendhal through the existentialists, selected from literatures of France, Germany, Italy, Russia, and Spain. (Walt)

CMLT 470. IBSEN AND THE CONTINENTAL DRAMA (3)
Emphasis on the major work of Ibsen, with some attention given to selected predecessors, contemporaries and successors.

CMLT 479. MAJOR CONTEMPORARY AUTHORS (3)

CMLT 488. GENRES (3)
A study of a recognized literary form, such as tragedy, epic, satire, literary criticism, comedy, tragicomedy, etc. The course may be repeated for cumulative credit up to six hours when different material is presented. (Russell)

CMLT 489. MAJOR WRITERS (3)
Each semester two major writers from different cultures and languages will be studied. Authors will be chosen on the basis of significant relationships of cultural and aesthetic contexts, analogies between their respective works, and the importance of each writer to his literary tradition.

CMLT 496. CONFERENCE COURSE IN COMPARATIVE LITERATURE (3)
Second semester. A tutorial type discussion course, correlating the courses in various literatures which the student has previously taken with the primary themes and masterpieces of world literature. This course is required of undergraduate majors in comparative literature, but must not be taken until the final year of the student's program. (Swigger)

CMLT 498. SELECTED TOPICS IN COMPARATIVE LITERATURE (3)

CMLT 601. PROBLEMS IN COMPARATIVE LITERATURE (3) (Swigger)

CMLT 610. FOLKLORE IN LITERATURE (3) (Goodwyn)

CMLT 631. THE MEDIEVAL EPIC (3) (Jones)

CMLT 632. THE MEDIEVAL ROMANCE (3) Herman, Jones)

CMLT 639. STUDIES IN THE RENAISSANCE (3)
Repeatable to a maximum of nine hours. (Salchenberger)

CMLT 640. THE ITALIAN RENAISSANCE AND ITS INFLUENCE (3) (Salchenberger)

CMLT 642. PROBLEMS OF THE BAROQUE IN LITERATURE (3)

CMLT 649. STUDIES IN EIGHTEENTH CENTURY LITERATURE (3)
Studies in Eighteenth Century literature: as announced. Repeatable to a maximum of 9 hours.

CMLT 658. STUDIES IN ROMANTICISM (3)
Studies in romanticism: as announced. Repeatable to a maximum of 9 hours. (Swigger)

CMLT 679. SEMINAR IN MODERN AND CONTEMPORARY LITERATURE (3)
Seminar in modern and contemporary literature: as announced. Repeatable to a maximum of nine hours.

CMLT 681. LITERARY CRITICISM—ANCIENT AND MEDIEVAL (3) (Greenwood)

CMLT 682. LITERARY CRITICISM — RENAISSANCE AND MODERN (3)

CMLT 799. MASTER'S THESIS RESEARCH (1-6)

CMLT 801. SEMINAR IN THEMES AND TYPES (3)

CMLT 899. DOCTORAL DISSERTATION RESEARCH (1-8)

COMPUTER SCIENCE PROGRAM

Professor and Director: Atchison
Professors: Chu,[1] Edmundson,[2] Glasser,[3] Heilprin,[4] Kanal, Minker
Associate Professors: Austing, Vandergraft
Assistant Professors: Agrawala, Basili, Feldman, Hagerty, Hamlet, McClellan, Mills, Noonan, Zelkowitz
Research Professors: Ortega,[5] Rheinboldt,[2] Rosenfeld

[1] joint appointment with Electrical Engineering
[2] joint appointment with Mathematics
[3] joint appointment with Physics
[4] joint appointment with Library and Information Services
[5] joint appointment with Institute for Fluid Dynamics and Applied Mathematics

The Computer Science Center offers graduate programs leading to the degrees of Master of Science and Doctor of Philosophy in the following areas: applications, computer systems, language and information processing, numerical analysis, and theory of computing.

Admission and degree requirements specific to the graduate programs in computer science are described

in a brochure available through the Education Office of the Computer Science Center. There are two options for the master's degree: 24 hours of course work plus the completion of a thesis; or 33 hours of course work plus the completion of a scholarly paper. There is no minimum course requirement in the doctoral program. The number and variety of courses offered each semester enables a student and his advisor to plan an individualized degree program.

Computers within the Computer Science Center include a dual processor UNIVAC 1108, a UNIVAC 1106, and a PDP 11/45.

CMSC 400. INTRODUCTION TO COMPUTER LANGUAGES AND SYSTEMS (3)
Prerequisite, MATH 241 or equivalent. A terminal course suitable for non-CMSC majors with no programming background. Organization and characteristics of computers. Procedure oriented and assembly languages. Representation of data, characters and instructions. Introduction to logic design and systems organization. Macro definition and generation. Program segmentation and linkage. Extensive use of the computer to complete projects illustrating programming techniques and machine structure. (CMSC 400 may not be counted for credit in the graduate program in computer science.)

CMSC 410. COMPUTER ORGANIZATION (3)
Prerequisite, CMSC 210 or equivalent. This is the same course as ENEE 440. Introduction. Computer elements. Parallel adders and subtracters. Microoperations. Sequences. Computer simulation. Organization of a commercially available stored program computer. Microprogrammed computers. A large-scale batch-processing system.

CMSC 420. DATA AND STORAGE STRUCTURES (3)
Prerequisite, CMSC 210 and 340 or equivalent. A study of intrinsic structures of data, such as arrays, strings, trees, and lists, and their relation to storage media. Representation of data structures in storage by records, files, etc. Special storage structures such as content addressed, trie, and associative memories. Referencing, processing, and management techniques based on the structuring, e.g., list processing. Storage and accessing efficiency, as well as dynamic flexibility of various methods.

CMSC 440. STRUCTURE OF PROGRAMMING LANGUAGES (3)
Prerequisite, CMSC 210 or equivalent. Formal definition of languages including specification of syntax and semantics. Syntactic structure and semantics of simple statements including precedence, infix, prefix, and postfix notation. Global structure and semantics of algorithmic languages including declarations and storage allocation, grouping of statements and binding time constituents, subroutines, coroutines, tasks and parameters. List processing and data description languages.

CMSC 450. ELEMENTARY LOGIC AND ALGORITHMS (3)
Prerequisite, MATH 240 or consent of instructor. This is the same course as MATH 444. An elementary development of propositional logic, predicate logic, set algebra, and Boolean algebra, with a discussion of Markov algorithms, Turing machines and recursive functions. Topics include post productions, word problems, and formal languages.

CMSC 460. COMPUTATIONAL METHODS (3)
Prerequisite, MATH 241 or 462, and CMSC 110 or equivalent. Study of the basic computational methods for interpolation, least squares, approximation, numerical quadrature, numerical solution of polynominal and transcendental equations, systems of linear equations and initial value problems for ordinary differential equations. The emphasis is placed on a discussion of the methods and their computational properties rather than on their analytic aspects. Intended primarily for students in the physical and engineering sciences. This course should not be taken by students who have passed MATH/CMSC 470. (Listed also as MATH 460.)

CMSC 470. INTRODUCTION TO NUMERICAL ANALYSIS (3)
Prerequisite, MATH 241. Introduction to the analysis of numerical methods for solving linear systems of equations, nonlinear equations in one variable, interpolation and approximation problems and the solution of initial value problems for ordinary differental equations. Emphasis on the theoretical foundations. Intended primarily for students in mathematics, applied mathematics, and computer science. Not open to students who have passed MATH/CMSC 460. (Listed also as MATH 470.)

CMSC 475. COMBINATORICS AND GRAPH THEORY (3)
Prerequisite, MATH 240 or equivalent. General enumeration methods, difference equations, generating functions. Elements of graph theory to transport networks, matching theory and graphical algorithms. (Listed also as MATH 475.)

CMSC 477. OPTIMIZATION (3)
Prerequisite, CMSC 110, and MATH 405 or MATH 474. Linear programming including the simplex algorithm and dual linear programs, convex sets and elements of convex programming, combinatorial optimization, integer programming. (Listed also as MATH 477 and STAT 477.)

CMSC 485. SIMULATION OF CONTINUOUS SYSTEMS (3)
Prerequisites, CMSC 110 and MATH 246, or equivalent. Introduction to digital simulation; simulation by Mimic programming; simulation by Fortran programming; simulation by DSL-90 (or CSMP) programming; logic and construction of a simulation processor; similarity between digital simulations of continuous and discrete systems.

CMSC 498. SPECIAL PROBLEMS IN COMPUTER SCIENCE (1-3)
Prerequisite, permission of instructor. An individualized course designed to allow a student or students to pursue a specialized topic or project under the supervision of the senior staff. Credit according to work done.

CMSC 600. PROGRAMMING SYSTEMS (3)
Prerequisites, CMSC 410, 420 and 440. Review of batch-process programming system, their components, operating characteristics, services and limitations. Concurrent processing of input-output

and interrupt handling. Structure of multiprogramming systems for large-scale multiprocessor computers. Addressing techniques, storage allocation, file management, systems accounting, and user-related services; command languages and the embedding of subsystems. Operating characteristics of large-scale systems.

CMSC 610. COMPUTER SYSTEMS (3)
Prerequisite, CMSC 410 or equivalent. Computer organization. Memory logic. Control logic. Numerical processors. Non-numerical processors. Computer architecture. On-line computer systems. Time-sharing computer systems. Computer networks. Analog and hybrid computer systems.

CMSC 620. INFORMATION PROCESSING (3)
Prerequisites, CMSC 420 and 440. Computers as devices for information processing. Definition, representation, and transformation of information. Complex information processing systems, techniques for studying information processing systems. Models of information processing systems. Processing or numeric data, formula processing. Processing of natural-language text. Picture processing. Machine intelligence. Applications to cognitive processes and problem-solving.

CMSC 630. THEORY OF PROGRAMMING LANGUAGES (3)
Prerequisite, CMSC 440. Syntactic and semantic models of programming languages. Finite state processors and their application to lexical analysis. Context free languages, LR(k), precedence languages as models of programming languages. Extensions to context free grammars such as property grammars, inherited and synthesized attributes, van Wijngaarden grammars (Algol 68), abstract syntax, the Vienna definition language, graph models. Translator writing systems.

CMSC 640. COMPUTABILITY AND AUTOMATA (3)
Prerequisite, CMSC 450, or equivalent. Introduction to the theories of computability and automata. This basic course establishes the foundation for all courses in the area of metatheory, mathematical models of computers, abstract machines, and formal languages. Topics covered include finite-state automata, neural networks, computability, effective procedures, algorithms, Turing machines, unsolvability results, recursive functions, post productions and canonical systems.

CMSC 660. ALGORITHMIC NUMERICAL ANALYSIS (3)
Prerequisites, MATH/CMSC 460 or 470, and CMSC 110. Detailed study of problems arising in the implementation of numerical algorithms on a computer. Typical problems include rounding errors, their estimation and control; numerical stability considerations; stopping criteria for converging processes; parallel methods. Examples from linear algebra, differential equations, minimization. (Also listed as MATH 684.)

CMSC 670. NUMERICAL ANALYSIS (3)
Prerequisite, MATH/CMSC 460 or 470, MATH 405 and MATH 410. Perturbation theorems for linear equations and eigenvalue problems. Stability of solutions of ordinary differential equations. Discretization errors for ordinary differential equations. Rounding error for linear equations. Convergence theorems for iterative methods for linear and nonlinear equations. (Listed also as MATH 683.)

CMSC 700. TRANSLATION OF PROGRAMMING LANGUAGES (3)
Prerequisites, CMSC 420 and 440. Application of theoretical concepts developed in formal language and automatic theory to the analytic design of programming languages and their processors. Theory of push-down automata, precedence analysis and bounded-context snytactic analysis as models of syntactic portion of translator design. Design criteria underlying compiler techniques, such as backtracking and look-ahead. Methods for analyzing translator operation in terms of estimating storage space and translation time requirements. Current version of Backus-Naur form. Associated semantic notations for specifying the operation of programming language translators.

CMSC 710. SIMULATION OF COMPUTERS AND SOFTWARE (3)
Prerequisite, CMSC 410 or equivalent. Computer simulation language, macro and micro simulation, Boolean translation, software-hardware transformation, description and simulation of a microprogrammed computer, construction and simulation of an assembler, project for unified hardware-software design.

CMSC 720. INFORMATION RETRIEVAL (3)
Prerequisite, CMSC 620. Designed to introduce the student to computer techniques for information organization and retrieval of natural language data. Techniques of statistical syntactic and logical analysis of natural language for retrieval, and the extent of their success. Methods of designing systems for use in operational environments. Applications to both data and document systems.

CMSC 723. COMPUTATIONAL LINGUISTICS (3)
Prerequisite, CMSC 620. Introductory course on applications of computational techniques to linquistics and natural-languages processing. Research cycle of corpus selection, pre-editing, keypunching, processing, post-editing, and evaluation. General-purpose input. Processing, and output routines. Special-purpose programs for sentence parsing and generation, segmentation, idiom recognition, paraphrasing, and stylistic and discourse analysis. Programs for dictionary, thesaurus, and concordance compilation, and editing. Systems for automatic abstracting, translation, and question-answering.

CMSC 725. MATHEMATICAL LINGUISTICS (3)
Prerequisites, CMSC 640 and STAT 400. Introductory course on applications of mathematics to linguistics. Elementary ideas in phonology, grammar, and semantics, automata, formal grammars and languages. Chomsky's theory of transformational grammars, Yngve's depth hypothesis and syntactic complexity. Markov-chain models of word and sentence generation, Shannon's information theory, Carnap and Bar-Hillel's semantic theory, lexicos-

tatistics and stylostatistics. Zopf's law of frequency and Mandelbrot's rank hypothesis. Mathematical models as theoretical foundation for computational linguistics.

CMSC 730. ARTIFICIAL INTELLIGENCE (3)
Prerequisites, CMSC 620 and STAT 401. Heuristic programming; tree research procedures. Programs for game playing, theorem finding and proving, problem solving; multiple-purpose programs. Conversation with computers; question-answering programs. Trainable pattern classifiers-linear, piecewise linear, quadratic, "Φ", and multilayer machines. Statistical decision theory, decision functions, likelihood ratios; mathematical taxonomy, cluster detection. Neural models, computational properties of neural nets, processing of sensory information, representative conceptual models of the brain.

CMSC 733. COMPUTER PROCESSING OF PICTORIAL INFORMATION (3)
Prerequisite, CMSC 620. Input, output, and storage of pictorial information. Pictures as information sources, efficient encoding, sampling, quantization, approximation. Position-invariant operations on pictures, digital and optical implementations, the PAX languages, applications to matched and spatial frequency filtering. Picture quality, "image enhancement" and "image restoration." Picture properties and pictorial pattern recognition. Processing of complex pictures: "figure" extraction, properties of figures. Data structures for picture description and manipulation: "picture languages." Graphics systems for alpha-numeric and other symbols, line drawings of two- and three-dimensional objects, cartoons and movies.

CMSC 737. TOPICS IN INFORMATION SCIENCE (3)
Prerequisite, permission of the instructor. This is the same course as LBSC 721. Definition of information science, relation to cybernetics and other sciences, systems analysis, information, basic constraints on information systems, processes of communication, classes and their use, optimalization and mechanization.

CMSC 740. AUTOMATA THEORY (3)
Prerequisite, CMSC 640. This is the same course as ENEE 652. Introduction to the theory of abstract mathematical machines. Structural and behavioral classification of automata. Finite-state automata; theory of regular sets. Pushdown automata. Linear-bounded automata. Finite transducers. Universal Turing machines.

CMSC 745. THEORY OF FORMAL LANGUAGES (3)
Prerequisite, CMSC 640. Formal grammars; syntax and semantics. Post productions; Markov algorithms. Finite-state languages, parsing, trees, and ambiguity. Theory of regular sets. Context-free languages; pushdown automata. Context-sensitive languages; linear-bounded automata. Unrestricted rewriting systems; Turing machines. Closure properties of languages under operations. Undecidability theorems.

CMSC 750. THEORY OF COMPUTABILITY (3)
Prerequisites, CMSC 640. Algorithms; Church's thesis. Primitive recursive functions; Gödel numbering. General and partial recursive functions. Turing machines; Turings' thesis. Markov algorithms. Church's Lambda calculus. Grzegorczyk hierarchy; Peter hierarchy. Relative recursiveness. Word problems, Post's correspondence problem.

CMSC 755. THEORIES OF INFORMATION (3)
Prerequisites, CMSC 620 and STAT 401. Mathematical and logical foundations of existing theories of information. Topics include Fisher's theory of statistical information, Kulback and Leibler's theory of statistical information, Shannon's theory of selective information, and Carnap and Bar-Hillel's theory of semantic information. The similarities and differences of these and other theories are treated.

CMSC 770. ADVANCED LINEAR NUMERICAL ANALYSIS (3)
Prerequisite, MATH/CMSC 470. Methods for the solution of linear systems of equations; in particular, iterative methods and their convergence theory. The numerical solution of the algebraic eigenvalue problem. (Also listed as MATH 694.)

CMSC 772. ADVANCED NONLINEAR NUMERICAL ANALYSIS (3)
Prerequisites, MATH/CMSC 670 and MATH 411. Iterative solution of nonlinear operator equations; in particular, nonlinear systems of equations. Existence question. Minimization methods and applications to approximation problems. (Also listed as MATH 696.)

CMSC 780. COMPUTER APPLICATIONS TO THE PHYSICAL SCIENCES (3)
Prerequisites, CMSC 210, STAT 400, and a graduate course in physical science. Applications of computers to numerical calculation, data reduction, and modeling in the physical sciences. Stress will be laid on the features of the applications which have required techniques not usually considered in more general contexts.

CMSC 782. MODELING AND SIMULATION OF PHYSICAL SYSTEMS (3)
Prerequisites, CMSC 210 and STAT 401. Monte-Carlo and other methods of investigating models of interest to physical scientists. Generation and testing of random numbers. Probabilistic, deterministic and incomplete models.

CMSC 798. GRADUATE SEMINAR IN COMPUTER SCIENCE (1-3)

CMSC 799. MASTER'S THESIS RESEARCH (1-6)

CMSC 818. ADVANCED TOPICS IN COMPUTER SYSTEMS (3)

CMSC 838. ADVANCED TOPICS IN INFORMATION PROCESSING (3)

CMSC 840. ADVANCED AUTOMATA THEORY (3)
Prerequisite, CMSC 740. Advances and innovations in automata theory. Variants of elementary automata; multitape, multihead, and multidimensional machines. Counters and stack automata. Wang machines; Shepherdson-Sturgis machines. Recursive hierarchies. Effective computability; relative uncomputability. Probabilistic automata.

CMSC 858. ADVANCED TOPICS IN THEORY AND METATHEORY (3)

CMSC 878. ADVANCED TOPICS IN NUMERICAL METHODS (3)

CMSC 898. ADVANCED TOPICS IN APPLICATIONS (3)

CMSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

COUNSELING AND PERSONNEL SERVICES PROGRAM

Professor and Chairman: Marx
Professors: Byrne, Holt, Magoon,[1, 2] Pumroy [1]
Associate Professors: Allen, Greenberg, Lawrence, Martin, Ray, Rhoads, Stern
Assistant Professors: Birk,[2] Carlson, Chasnoff, Colby, Freeman,[1] Gump, Kafka, Krieger, Magrab, Medvene,[2] Spielbichler, Westbrook [2]

[1] joint appointment with Psychology
[2] joint appointment with Counseling Center

Historically, the programs of the Department of Counseling and Personnel Services have been responsive to societal needs in providing leadership in the training of specialized personnel service workers. The programs are designed for the preparation of professionals who serve in a variety of social settings including schools, colleges, rehabilitative agencies, government agencies and other community agencies. These professionals may serve one of several roles either at the practitioner's level or at an advanced level of leadership, supervision and research. Programs of preparation for practitioners are offered at the Master's and Advanced Graduate Specialist level while the advanced offerings for researchers, supervisors, and personnel administrators are conducted at the Doctoral level. The Master's and Advanced Graduate Specialist programs are offered among the following six specialty programs within the department: The Elementary School Counseling Specialty Program prepares the student as a child development consultant, individual and group counselor and coordinator of pupil services. The Secondary School Counseling Program prepares the student to serve as a member of a human resources team in individual and group counseling, information specialist regarding personnel, social, educational and vocational matters, and pupil personnel program coordination. The Psychological Services in Schools Program prepares the student to be certified as a school psychologist where his principal functions are to assess psychological conditions and devise intervention strategies to enhance the learning of pupils. The College Student Personnel Specialty Program prepares specialists at the higher education level in two areas of concentration: college counseling and Student Personnel Administration which includes areas such as Student Activities, Student Union, Housing, Admissions, Placement, Deans of Students and Vice Presidents of Student Affairs. The Community Counseling Specialty Program provides two emphases within the program. Career development and vocational counseling is one concentration and the other concentration is personal-social counseling and community mental health consultation. The Rehabilitation Counseling Specialty Program prepares counselors to work with mentally, emotionally, socially and physically handicapped persons in public and private agencies.

The doctoral programs in Counseling and Personnel Services are designed to prepare students to achieve exceptional competence in the areas of research, theory, and practice related to personnel services. Graduates typically assume positions of leadership, research or supervision of personnel services in public units such as large school systems, universities, or state rehabilitation and community agencies; as professors in personnel service programs; as counselors in higher education institutions. The doctoral program, leading to the Doctor of Philosophy degree, has as its major emphasis research in the behavioral sciences and applied fields. The primary thrust at the Master's and Advanced Graduate Specialist levels is upon excellence in practice; the major emphasis at the Doctoral level is upon theory and research.

Admission to these programs is based not only on meeting minimum requirements but competitively based on staff resources available.

EDCP 410. INTRODUCTION TO COUNSELING AND PERSONNEL SERVICES (3)
Presents principles and procedures, and examines the function of counselors, psychologists in schools, school social workers, and other personnel service workers.

EDCP 411. MENTAL HYGIENE (3)
The practical application of the principles of mental hygiene to classroom problems.

EDCP 413. BEHAVIOR MODIFICATION (3)
Knowledge and techniques of intervention in a variety of social situations, including contingency contracting and time out will be acquired.

EDCP 414. PRINCIPLES OF BEHAVIOR (3)
Development of student proficiency in analyzing complex patterns of behavior on the basis of emperical evidence.

EDCP 415. BEHAVIOR MEDIATION (3)
Prerequisite: EDCP 414. Basic principles of human behavior will be reviewed and application of these principles will be implemented under supervision.

EDCP 417. GROUP DYNAMICS AND LEADERSHIP (3)
Two hours of lecture-discussion and two hours of laboratory per week; laboratory involves experimental-based learning. The nature and property of groups, interact on analysis, developmental phases, leadership dynamics and styles, roles of members and interpersonal communications.

EDCP 420. EDUCATION AND RACISM (3)
Strategy development for counselors and educators to deal with problems of racism.

EDCP 460. INTRODUCTION TO REHABILITATION COUNSELING (3)
Introductory course for majors in rehabilitation counseling, Social Work, Psychology, or Education who desire to work professionally with physically or emotionally handicapped persons.

EDCP 470. INTRODUCTION TO STUDENT PERSONNEL (3)
Prerequisite, consent of instructor. A systematic

analysis of research and theoretical literature on a variety of major problems in the organization and administration of student personnel services in higher education. Included will be discussion of such topics as the student personnel philosophy in education, counseling services, discipline, housing, student activities, financial aid, health, remedial services, etc.

EDCP 489. FIELD EXPERIENCE IN COUNSELING AND PERSONNEL SERVICES (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in which the experience is to be taken. Planned field experience may be provided for selected students who have had departmental experience and whose application for such field experience has been approved by the departmental faculty. Field experience is offered in a given area to both major and nonmajor students: *Note:* the total number of credits which a student may earn in EDCP 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDCP 499. WORKSHOPS, CLINICS, INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the Department of Counseling and Personnel Services (or developed cooperatively with other departments, colleges and universities) and not otherwise covered in the present course listing; clinical experiences in counseling and testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups.

EDCP 611. OCCUPATIONAL CHOICE THEORY AND INFORMATION (3)
Research and theory related to occupational and educational decisions; programs of related information and other activities in occupational decision.

EDCP 614. PERSONALITY THEORIES IN COUNSELING AND PERSONAL SERVICES (3)
Examinating of constructs and research relating to major personality theories with emphasis on their significance for working with the behaviors of individuals.

EDCP 615. CASES IN APPRAISAL (3)
Prerequisite, EDMS 446 or EDMS 451. Collecting and interpreting non-standardized pupil appraisal data; synthesis of all types of data through case study procedures.

EDCP 616. COUNSELING — THEORETCAL FOUNDATIONS AND PRACTICE (3)
Prerequisite, EDCP 615. Exploration of learning theories as applied to counseling in school, and practices which stem from such theories.

EDCP 617. GROUP COUNSELING (3)
Prerequisite, EDCP 616. A survey of theory, research and practice of group counseling and psychotherapy with an introduction to growth groups and the laboratory approach. Including therapeutic factors in groups, composition of therapeutic groups, problem clients, therapeutic techniques, research methods, theories, ethics and training of group counselors and therapists.

EDCP 619. PRACTICUM IN COUNSELING (2-6)
Prerequisites, EDCP 616 and permission of instructor. Sequence of supervised counseling experiences of increasing complexity. Limited to eight applicants in advance. Two hours class plus laboratory.

EDCP 626. GROUP COUNSELING PRACTICUM (3)
Prerequisite, EDCP 617, EDCP 619, and consent of instructor. A supervised field experience in group counseling.

EDCP 627. PROCESS CONSULTATION (3)
Prerequisite, a graduate course in Group Process. Study of case consultation, systems consultation, mental health consultation and the professional's role in systems intervention strategies.

EDCP 633. DIAGNOSTIC APPRAISAL OF CHILDREN I (4)
Assessment of development, emotional and learning problems of children in schools.

EDCP 634. DIAGNOSTIC APPRAISAL OF CHILDREN II (4)
Prerequisite, EDCP 633. Assessment of adolescents in schools.

EDCP 635. THERAPEUTIC TECHNIQUES WITH CHILDREN AND CLASSROOM MANAGEMENT I (3)
Prerequisite, EDCP 414. Diagnosis and treatment of children's problems by teachers and parents. Practicum experience.

EDCP 636. THERAPEUTIC TECHNIQUES WITH CHILDREN AND CLASSROOM MANAGEMENT II (3)
Prerequisite, EDCP 635. The objective of this course is to understand and to treat children's problems. The focus is primarily on the older child in secondary school and the orientation is essentially behavioral. Practicum experience will be provided.

EDCP 645. COUNSELING IN ELEMENTARY SCHOOLS (3)
Prerequisite, EDCP 615 or consent of instructor, Counseling theory and practices as related to children. Emphasis will be placed on an awareness of the child's total behavior as well as on specific methods of communicating with the child through techniques of play interviews, observations, and the use of non-parametric data.

EDCP 655. ORGANIZATION AND ADMINISTRATION OF PERSONNEL SERVICES (2)
Prerequisite, EDCP 619 or permission of instructor. Exploration of personnel services programs and implementing personnel services practices.

EDCP 656. COUNSELING AND PERSONNEL SERVICES SEMINAR (2)
Prerequisite, advanced standing. Examination of issues that bear on professional issues such as ethics, interprofessional relationships and research.

EDCP 661. PSYCHO-SOCIAL ASPECTS OF DISABILITY (3)
Prerequisite, EDCP 460 or consent of instructor. This course is part of the core curriculum for rehabilitation counselors. It is designed to develop an understanding of the nature and importance of the personal and psycho-social aspects of adult disability.

EDCP 662. PSYCHIATRIC ASPECTS OF DISABILITY I (3)
Prerequisite: EDCP 460 or equivalent and consent of instructor. Part of core curriculum in rehabilitation counseling. It is designed to develop an understanding of the rehabilitation process, clients served, and skills and attitudes necessary for working effectively with the physically disabled.

EDCP 663. PSYCHIATRIC ASPECTS OF DISABILITY II (3)
Prerequisite: EDCP 460 or equivalent and consent of instructor. Part of core curriculum in rehabilitation counseling. The psychiatric rehabilitation client: understanding his needs, treatment approaches available and society's reaction to the client.

EDCP 668. SPECIAL TOPICS IN REHABILITATION: As Announced (1-6)
Repeatable to a maximum of 6 hours.

EDCP 718. ADVANCED SEMINAR IN GROUP PROCESSES. Topics As Announced (3)
Prerequisite, EDCP 626. Repeatable to a maximum of 6 credits.

EDCP 735. SEMINAR IN REHABILITATION COUNSELING (2)
This course is part of the core curriculum for rehabilitation counselors. It is designed to provide the advanced rehabilitation counseling student with a formal seminar to discuss, evaluate and attempt to reach personal resolution regarding pertinent professional problems and issues in the field.

EDCP 771. THE COLLEGE STUDENT (3)
A demographic study of the characteristics of college students as well as a study of their aspirations, values, and purposes.

EDCP 776. MODIFICATION OF HUMAN BEHAVIOR: LABORATORY AND PRACTICUM (3)
Prerequisite: permission of instructor. Individual and group supervised introduction to intake and counseling relationships.

EDCP 777. MODIFICATION OF HUMAN BEHAVIOR: LABORATORY AND PRACTICUM (3)
Prerequisite: EDCP 776 and permission of instructor. Continuation of EDCP 776. Further experience under direct supervision of more varied forms of counseling relationships.

EDCP 778. SEMINAR IN STUDENT PERSONNEL (2-6)
An intensive study of the various student personnel functions. A means to integrate the knowledge from various fields as they relate to student personnel administration.

EDCP 788. ADVANCED PRACTICUM IN COUNSELING (1-6)
Prerequisite: Permission of instructor. Individual supervision of counseling and group consultation. Repeatable to a maximum of 6 hours.

EDCP 789. ADVANCED TOPICS IN COUNSELING AND PERSONNEL SERVICES (1-6)
Prerequisite: Consent of the instructor. Designed primarily for students majoring in Counseling and Personnel Services to focus in depth on contemporary professional issues. Topics will be announced but will typically relate to areas of counseling theory, career development, and mediation and personality development.

EDCP 798. SPECIAL PROBLEMS IN COUNSELING AND PERSONNEL SERVICES (1-6)
Master's, AGS, or Doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number.

EDCP 799. MASTER'S THESIS RESEARCH (1-6)
Six hours required for master's thesis.

EDCP 888. APPRENTICESHIP IN COUNSELING AND PERSONNEL SERVICES (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the departmental faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, work experience, a Master's degree, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDCP 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDCP 889. INTERNSHIP IN COUNSELING AND PERSONNEL SERVICES (3-16)
Internship in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the doctor's degree; and (b) any student who receives special approval by the departmental faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a work situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *NOTE:* The total number of credits which a student may earn in EDCP 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDCP 899. DOCTORAL DISSERTATION (1-8)
Six to nine hours required for an EdD project and 12-18 hours required for a PhD dissertation.

CRIMINAL JUSTICE AND CRIMINOLOGY PROGRAM

Professor and Director: Lejins
Associate Professor: Maida
Assistant Professors: Ingraham, Johnson

A program of graduate study leading to a Master of Arts in the area of Criminal Justice and Criminology prepares students for research, teaching and professional employment in the operational agencies in the field of criminal justice. The program, offered by the Institute of Criminal Justice and Criminology, combines an intensive background in a social science discipline such as sociology, psychology, or public administration, with graduate level study of selected aspects of the criminal justice. Presently a Ph.D. program in Sociology with a specialization in Criminology is available as a continuation of the M.A program for students meeting the qualifications.

Students enrolled in the program have two options: a Criminology option and a Criminal Justice option. The general requirements for both options are:

1. Three social science courses on an appropriate level in theory, methodology and statistics.
2. Three appropriate-level courses in Criminology or Law Enforcement, depending on the option. One of these should be a general seminar dealing with the over-all field of criminal justice.
3. Two elective courses.
4. The student has a choice between:
   a. an M.A degree with an M.A. thesis, in which case the student is required to register for six M.A. thesis credits;
   b. an M.A. degree without thesis, in which case the student is required to register for two additional three-credit courses instead of the six thesis credits. One of these additional courses must be in Criminology/Law Enforcement, depending on the option. In addition the student is required to prepare two research papers in two 600-level courses, at least one of which must be a Criminology/Law Enforcement course, depending on the option. The student is also required to take comprehensive M.A examinations appropriate to the option.

The choice between the two above options (a) and (b) is up to the student; it is, however, anticipated that students planning their careers around research and teaching will take the thesis option, while those interested primarily in the operational aspects of the field of criminal justice will probably select the non-thesis option.

The selection of the courses should be made in consultation and with the approval of a faculty advisor.

Special admission requirements include the Graduate Record Examination Aptitude Test, a major in a social science discipline, and 9 hours of course work in the appropriate area of criminal justice. The undergraduate social science major must have included at least one course each in theory, statistics and research methods. At the discretion of the Graduate Admissions Committee of the Institute, deficiencies in some of the above areas may be made up by non-credit work at the beginning of the graduate program.

CRIMINOLOGY

CRIM 432. LAW OF CORRECTIONS (3)
Prerequisite: LENF 230 or 234 and CRIM 220. A review of the law of criminal corrections from sentencing to final release on parole. Probation, punishments, special treatments for special offenders, parole and pardon, and the expanding field of prisoner's civil rights are also examined.

CRIM 450. JUVENILE DELINQUENCY (3)
Prerequisite: SOCY 100. Juvenile delinquency in relation to the general problem of crime; analysis of factors underlying juvenile delinquency; treatment and prevention. (Lejins, Maida)

CRIM 451. CRIME AND DELINQUENCY PREVENTION (3)
Prerequisites: CRIM 220 or CRIM 450 or consent of instructor. Methods and programs in prevention of crime and delinquency. (Debro, Lejins, Maida)

CRIM 452. TREATMENT OF CRIMINALS AND DELINQUENTS IN THE COMMUNITY (3)
Prerequisite: CRIM 220 or CRIM 450 or consent of instructor. Analysis of the processes and methods in the modification of criminal patterns of behavior in a community setting.

CRIM 453. INSTITUTIONAL TREATMENT OF CRIMINALS AND DELINQUENTS (3)
Prerequisite: CRIM 220 or CRIM 450 or consent of instructor. History, organization and functions of penal and correctional institutions for adults and juveniles. (Debro, Lejins, Maida)

CRIM 454. CONTEMPORARY CRIMINOLOGICAL THEORY (3)
Prerequisite: CRIM 220 and CRIM 450 and one additional course selected from CRIM 451, 452 or 453. Brief historical overview of criminological theory up to the 50's. Deviance. Labeling. Typologies. Most recent research in criminalistic subcultures and middle class delinquency. Recent proposals for "decriminalization."

CRIM 498. SELECTED TOPICS IN CRIMINOLOGY: AS ANNOUNCED (3)
Topics of special interest to advanced undergraduates in criminology. Such courses will be offered in response to student request and faculty interest. No more than six credits may be taken by a student in selected topics.

CRIM 650. ADVANCED CRIMINOLOGY (3)
Survey of the principal issues in contemporary criminological theory and research.

CRIM 651. SEMINAR — CRIMINOLOGY (3)

CRIM 652. SEMINAR — JUVENILE DELINQUENCY (3)

CRIM 653. CRIME AND DELINQUENCY AS A COMMUNITY PROBLEM (3)
An intensive study of selected problems in adult crime and juvenile delinquency in Maryland.

CRIM 699. SPECIAL CRIMINOLOGICAL PROBLEMS (3)

CRIM 799. MASTER'S THESIS RESEARCH (1-6)

LENF 444. ADVANCED LAW ENFORCEMENT ADMINISTRATION (3)
Prerequisite: LENF 340 or consent of instructor. The structuring of manpower, material, and systems to accomplish the major goals of social control. Personnel and systems management. Political controls and limitations on authority and jurisdiction.

LENF 460. INDUSTRIAL AND RETAIL SECURITY ADMINISTRATION (3)
Prerequisite: LENF 100, 220 and 340 or consent of instructor. The origins of contemporary private security systems. Organization and management of industrial and retail protective units.

LENF 462. SPECIAL PROBLEMS IN SECURITY ADMINISTRATION (3)
Prerequisites: LENF 100, 220, 360/460 *and* consent of instructor. An advanced course for students desiring to focus on specific concerns in the study of private security organizations; business intelligence and espionage; vulnerability and criticality analyses in physical security; transportation, banking, hospital and military security problems; uniformed security forces; national defense information; and others.

LENF 498. SELECTED TOPICS IN CRIMINAL JUSTICE (1-6)
Prerequisite: consent of instructor. Supervised study of a selected topic in the field of criminal justice.

LENF 600. CRIMINAL JUSTICE (3)
Prerequisites: Admission to the graduate program in Criminal Justice or consent of instructor. Current concept of criminal justice in relationship to other concepts in the field. Historical perspective. Criminal justice and social control. Operational implications. Systemic aspects. Issues of evaluation.

LENF 630. SEMINAR IN CRIMINAL LAW AND SOCIETY (3)
Prerequisite: LENF 230 or its equivalent and a course in introductory criminology. The criminal law is studied in the context of general studies in the area of the sociology of law. The evolution and development of criminal law from primitive to modern times, and social and psychological factors affecting the formulation and administration of criminal laws are discussed. Also examined is the impact of criminal laws and their sanctions on behavior in the light of recent empirical evidence.

LENF 640. SEMINAR IN CRIMINAL JUSTICE ADMINISTRATION (3)
Prerequisites: (a) one course in the theory of groups or organizations, (b) one course in administration; or consent of instructor. Examination of external and internal factors that currently impact on police administration. Intra-organizational relationships and policy formulation; the conversion of inputs into decisions and policies. Strategies for formulating, implementing and assessing administrative decisions.

LENF 699. SPECIAL PROBLEMS IN CRIMINAL JUSTICE (1-3)
Prerequisite: consent of instructor. Supervised study of a selected problem in the field of criminal justice.

LENF 799. MASTER'S THESIS RESEARCH (1-6)

DAIRY SCIENCE PROGRAM

Professor and Acting Chairman: Mattick
Professors: Cairns, Davis, Keeney,[1] King, Mattick, Vandersall, Williams
Assistant Professors: Bull, Douglass, Westhoff

[1] joint appointment with Chemistry

The Department of Dairy Science offers work leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for the Doctor of Philosophy degree have the option of studying in one of two major fields: dairy production, which is concerned with breeding, nutrition and physiology of dairy animals; or dairy technology, which is concerned with chemical, bacteriological, and nutritional aspects of dairy products, as well as the industrial phases of milk processing.

Students interested in food science may undertake graduate study in the dairy technology phase of Dairy Science, or in the food science curriculum. Courses in these programs are listed under the headings Animal Science and Food Science respectively.

DANCE COURSES

DANC 400. ADVANCED CHOREOGRAPHIC FORMS (3)
Prerequisite, DANC 208 or equivalent and adequate dance technique. Lectures and studio work in modern sources as they apply to dance. (Solo and group choreography.)

DANC 465. ADVANCED NOTATION (3)
Prerequisite, DANC 365 or equivalent. Continuation of materials in DANC 365 in more intensive work. The translation, writing, and performing of advanced scores in the various forms of dance.

DANC 468. REPERTORY (3)
The learning of dances to be chosen from notated scores, works of visiting artists, or selected faculty choregraphy to be performed on at least one concert. Audition required. The course may be repeated for credit, as different works will be chosen each semester.

DANC 470. CREATIVE DANCE FOR CHILDREN (3)
Prerequisite, DANC 208 and 305 or equivalent. Directing the essential elements of dance to the level of the child's experience and facilitating the creative response. The development of movement into simple forms to serve as a symbol of individual expression.

DANC 478. DANCE PRODUCTION (3)
Prerequisite, DANC 458 or equivalent and an adequate understanding of dance techniques. Ad-

vanced choreography. Independent work with periodic criticism.

DANC 482. HISTORY OF DANCE (3)
The development of dance from primitive to the Middle Ages and the relationship of dance forms to patterns of culture.

DANC 483. HISTORY OF DANCE (3)
The development of dance from the Renaissance Period to the present times and the relationship of dance forms to patterns of culture.

DANC 484. THEORY AND PHILOSOPHY OF DANCE (3)
The study of the theories, philosophies and aesthetics of dance. Investigation of form, content and structure. Interrelationships of the arts, and their role in man's world.

DANC 489. ETHNIC STYLES (3)
Prerequisite, DANC 104. Lecture and activity in styles expressive of various cultures. May be repeated for credit by permission of instructor.

DANC 492. PERCUSSION AND MUSIC SOURCES FOR DANCE (3)
Prerequisite, DANC 102 or equivalent. Techniques of percussion playing, and its use as dance accompaniment. Learning to use the instruments in composition and improvisation. Study of music sources for dance.

DANC 498. DIRECTED STUDIES IN DANCE (1-6)
Hours arranged. For advanced students who have the permission of the chairman of the Department of Dance.

DANC 499. ADVANCED DANCE TECHNIQUE (2)
Prerequisite, DANC 389 or equivalent. Continuation of DANC 389 in further advanced form.

EARLY CHILDHOOD-ELEMENTARY EDUCATION PROGRAM

Professor and Chairman: Weaver
Professors: Ashlock, Duffey, Goff, Hall, Leeper, O'Neill, J. Wilson, R. Wilson
Associate Professors: Amershek, Dietz, Eley, Gantt, Heidelbach, Herman, Roderick, Sullivan, Williams
Assistant Professors: Butler, Church, Hutchings, Jantz, Johnson, McCuaig, Moretz, Schumacher, Seefeldt, Yawkey

Graduate programs leading to M.A., M.E.D. and Ph.D. degrees in the Department of Early Childhood-Elementary Education are designed to prepare teachers, curriculum specialists, supervisors, administrators, and higher education instructors to function effectively in leadership positions involving programs for young children.

Students have opportunities to specialize in any of the following areas: early childhood education, elementary education, corrective-remedial reading instruction, science education, mathematics education, language arts, social studies education, or nursery-kindergarten education.

Special facilities for graduate study include the Reading Center, the Arithmetic Center, the Science Teaching Center, the Maryland Reading Resource Network of ERIC-CRIER, the Center for Young Children.

Programs, particularly at the doctoral level, are individualized to reflect the student's background and to meet his particular career goals. Regular counseling with an advisor is an important aspect of each program. An effort is made to ascertain that graduate programs include both theory and practicum; professional work and academic courses.

EDEL 401. SCIENCE IN EARLY CHILDHOOD EDUCATION (3)

EDEL 402. SCIENCE IN THE ELEMENTARY SCHOOL (3)
Designed to help teachers acquire general science understandings and to develop teaching materials for practical use in classrooms. Includes experiments, demonstrations, constructions, observations, field trips and use of audio-visual materials. The emphasis is on content and method related to science units in common use in elementary schools.

EDEL 404. LANGUAGE ARTS IN EARLY CHILDHOOD EDUCATION (3)
Teaching of spelling, handwriting, oral and written expression, and creative expression.

EDEL 405. LANGUAGE ARTS IN THE ELEMENTARY SCHOOL (3)

EDEL 406. SOCIAL STUDIES IN EARLY CHILDHOOD EDUCATION (3)

EDEL 407. SOCIAL STUDIES IN THE ELEMENTARY SCHOOL (3)
Consideration given to curriculum, organization and methods of teaching, evaluation of newer materials, and utilization of environmental resources.

EDEL 410. THE CHILD AND THE CURRICULUM — EARLY CHILDHOOD (3)

EDEL 411. THE CHILD AND THE CURRICULUM — ELEMENTARY (3)
Relationship of the elementary school curriculum to child growth and development. Recent trends in curriculum organization; the effect of environment on learning; readiness to learn; adapting curriculum content and methods to maturity levels of children.

EDEL 412. ART IN THE ELEMENTARY SCHOOL (3)
Concerned with art methods and materials for elementary schools. Includes laboratory experiences with materials appropriate for elementary schools.

EDEL 413. MATHEMATICS IN EARLY CHILDHOOD EDUCATION (3)

EDEL 414. MATHEMATICS IN THE ELEMENTARY SCHOOL (3)
Emphasis on materials and procedures which help pupils sense arithmetical meanings and relationships. Helps teachers gain a better understanding of the number system and arithmetical processes.

EDEL 424. LITERATURE FOR CHILDREN AND YOUNG PEOPLE (3)
Development of literary materials for children and young people. Timeless and ageless books, and outstanding examples of contemporary publishing.

Evaluation of the contributions of individual authors and illustrators and children's book awards.

EDEL 425. THE TEACHING OF READING — EARLY CHILDHOOD (3)
Concerned with the fundamentals of developmental reading instruction, including readiness, use of experience records, procedures in using basal readers, the improvement of comprehension, teaching reading in all areas of the curriculum, uses of children's literature, the program in word analysis, and procedures of determining individual needs.

EDEL 426. THE TEACHING OF READING — ELEMENTARY (3)
Concerned with the fundamentals of developmental reading instruction, including readiness, use of experience records, procedures in using basal readers, the improvement of comprehension, teaching reading in all areas of the curriculum, uses of children's literature, the program in word analysis, and procedures for determining individual needs.

EDEL 430. CORRECTIVE-REMEDIAL READING INSTRUCTION (3)
Prerequisite, EDEL 326 or equivalent. For teachers, supervisors, and administrators who wish to identify and assist pupils with reading difficulties. Concerned with diagnostic techniques, instructional materials and teaching procedures useful in the regular classroom.

EDEL 431. LABORATORY PRACTICES IN READING (3)
Prerequisite, EDEL 430. A laboratory course in which each student has one or more pupils for analysis and instruction. At least one class meeting per week to diagnose individual cases and to plan instruction.

EDEL 489. FIELD EXPERIENCE IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in which the experience is to be taken. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field experience has been approved by the education faculty. Field experience is offered in a given area to both major and nonmajor students. *Note:* the total number of credits which a student may earn in EDEL 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDEL 498. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDEL 499. WORKSHOP, CLINICS, AND INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following types of educational enterprise may be scheduled under this course heading: workshops conducted by the college of education (or developed cooperatively with other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, arithmetic clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDEL 600. SEMINAR IN ELEMENTARY EDUCATION (3)
Primarily for individuals who wish to write seminar papers. Prerequisite, at least 12 hours of graduate work in education.

EDEL 601. PROBLEMS IN TEACHING SCIENCE IN ELEMENTARY SCHOOLS (3)
Prerequisite, EDEL 401 or approval of instructor. Provides opportunity for students to analyze the teaching of science in the elementary school through (1) the identification of problems of teaching, (2) the investigation and study of reported research related to the stated problems; and (3) the hypothesizing of methods for improving the effectiveness of elementary school science programs. Students will also have the opportunity to study and evaluate newer programs and practices in the teaching of science in the elementary school.

EDEL 605. PROBLEMS OF TEACHING LANGUAGE ARTS IN ELEMENTARY SCHOOLS (3)
Prerequisite, EDEL 404 or approval of instructor. This course is designed to allow each student an opportunity (1) to analyze current issues, trends, and problems in language-arts instruction in terms of research in fundamental educational theory and the language arts, and (2) to use this analysis in effecting changes in methods and materials for classroom instruction.

EDEL 607. PROBLEMS OF TEACHING SOCIAL STUDIES IN ELEMENTARY SCHOOLS (3)
Prerequisite, EDEL 406 or approval of instructor. An examination of current literature and research reports in the social sciences and in social studies curriculum design and instruction, with an emphasis on federally-sponsored projects as well as programs designed for urban children.

EDEL 614. PROBLEMS OF TEACHING MATHEMATICS IN ELEMENTARY SCHOOLS (3)
Prerequisite, EDEL 413 or approval of instructor. Critical examination of selected theory and research in the teaching of mathematics in elementary schools. Evaluation of instructional materials. Implications for practice.

EDEL 615. DIAGNOSIS AND REMEDIATION OF ARITHMETIC DISABILITIES (3)
Prerequisite, EDEL 313 or 314 and EDMS 446 or equivalent. For those who wish to increase compentency in diagnosing and correcting arithmetic disabilities. Concerned with classroom and clinical techniques, instructional materials, and remedial procedures useful to the teacher or clinician in (1) diagnosing serious arithmetic difficulties and (2) planning programs of individual and small-group

remediation. The work includes the writing of diagnostic and progress reports.

EDEL 626. PROBLEMS IN THE TEACHING OF READING IN THE ELEMENTARY SCHOOL (3)
Implications of current theory and the results of research for the teaching of reading in the elementary school. Attention is given to all areas of developmental reading instruction, with special emphasis on persistent problems.

EDEL 630. DIAGNOSIS AND REMEDIATION OF READING DISABILITIES (3)
Prerequisites, minimum of 15 hours including EDEL 430, EDEL 626, EDMS 446 and 622. For those who wish to become concerned with clinical diagnostic techniques, instructional materials, and remedial procedures useful to the reading specialist in (1) diagnosing serious reading difficulties, and (2) planning programs of individual and small group instruction.

EDEL 631. ADVANCED LABORATORY PRACTICES (DIAGNOSIS) (3)
Prerequisite, EDEL 630. Diagnostic work with children in clinic and school situations. Administration, scoring, interpretation, and prescription via diagnostic instruments is stressed. Case report writing and parent conferences are also stressed. EDEL 631 is taken with EDEL 632.

EDEL 632. ADVANCED LABORATORY PRACTICES (INSTRUCTION) (3)
Prerequisite, EDEL 630. Remedial instruction with children in clinic and school situations. Develop competency in various remedial techniques, diagnostic teaching, and evaluation. Development of the reading resource role is stressed. EDEL 632 is taken with EDEL 631.

EDEL 640. CURRICULUM PLANNING IN NURSERY-KINDERGARTEN EDUCATION (3)
An examination of significant new developments in curriculum theory and practice.

EDEL 641. THE YOUNG CHILD IN THE COMMUNITY (3)
Planned observation, related research, and analysis of the experiences of young children in such community centers as foster homes, orphanages, day care centers, Sunday schools, etc. One-half day a week observation required.

EDEL 642. THE YOUNG CHILD IN SCHOOL (3)
An examination of significant theory and research on the characteristics of young children which have special implications for teaching children in nursery-kindergarten groups.

EDEL 643. TEACHER-PARENT RELATIONSHIPS (3)
A study of the methods and materials, trends, and problems in establishing close home-school relationships.

EDEL 644. INTELLECTUAL AND CREATIVE EXPERIENCES OF THE NURSERY-KINDERGARTEN CHILD (3)
A critical examination of materials, methods and programs in such areas as reading, literature, science, mathematics, the social studies, art, music, dance, etc.

EDEL 650. SEMINAR IN EARLY CHILDHOOD EDUCATION (3)
A program seminar in early childhood education. Prerequisites: at least 12 hours of graduate work in early childhood education.

EDEL 651. PROBLEMS OF STAFFING IN EARLY CHILDHOOD EDUCATION (3)
Prerequisite — doctoral study in early childhood education or administration, administrative experience or consent of the instructor.

EDEL 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number

EDEL 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for master's thesis.

EDEL 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's Degree in education, and at least six semester hours in education at the University of Maryland. *Note:* the total number of credits which a student may earn in EDEL 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDEL 889. INTERNSHIP IN EDUCATION (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the Doctor's Degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *Note:* the total number of credits which a student may earn in EDEL 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDEL 899. DOCTORAL DISSERTATION RESEARCH (1-16)
Six to nine hours required for an EdD project and 12-18 hours required for a PhD dissertation.

ECONOMICS PROGRAM

Professor and Chairman: Dillard
Professors: Adelman, Almon, Bergmann, Cumberland, Gruchy, Harris, McGuire, O'Connell, Olson, Schultze, Ulmer, Wonnacott
Associate Professors: Aaron, Adams, Bennett, Clague, Dodge, Dorsey, Knight, McLoone,[1] Meyer, Singer, Straszheim, Weinstein
Assistant Professors: Atkinson, Betancourt, Boorman, Christensen, Greer, King, Layher, MacRae, Madan, Peterson, Qualls, Schiller, Whitman
Lecturers: Hinrichs, Measday, Pierce, Snow

[1] joint appointment with Education; Administration, Supervision and Curriculum

Programs are offered leading to the Master of Arts and Doctor of Philosophy degrees. Areas of specialization include: economic theory, comparative economic systems and planning, economic development, economic history, history of economic thought, industrial organization, institutional economics, international economics, labor economics, mathematical economics and econometrics, monetary economics, public finance, regional and urban economics, and social policy.

Applicants should have taken (or should plan to take immediately) at least one undergraduate course in each of micro-economics, macro-economics, statistics, and calculus. The submission of the Graduate Record Examination scores on the Aptitude Test is required and on the Advanced Economics Test is recommended. Letters of recommendation from three persons competent to judge the probability of the applicant's success in graduate school should be sent directly to the Director of Graduate Studies in Economics. Preference is given to applicants for full-time graduate study.

The Master of Arts degree in Economics may be taken under either (1) the thesis option (24 hours plus a thesis) or (2) the non-thesis option (30 hours, including Economics 621-622 plus a written examination in Economic Theory). The requirements for the non-thesis option for the M.A. are met automatically in the course of the Ph.D. program in Economics.

The main requirements of the Ph.D. program are (1) a written examination in economic theory, normally taken at the beginning of the second year of full-time graduate study; (2) written examinations in two approved optional fields; (3) a comprehensive oral examination covering economic theory and the two optional fields; (4) two courses (Econ 621-622) in Quantitative Methods in Economics; (5) two courses (Econ 606-607) in the History of Economic Thought; (6) foreign language or one of several options; (7) a seminar paper to be available to the faculty at the time of the oral comprehensive examination; (8) a dissertation and its successful oral defense.

The graduate program in Economics is a comprehensive one. The department possesses special strength in the Economics of the Public Sector. Special research projects under the supervision of faculty members are being carried on in the Economics of Discrimination (by race and sex), the Economics of Environmental Management, and Interindustry Forecasting. Research assistantships are available in each of these projects. Numerous teaching assistantships are also available. The department can usually help graduate students find half-time employment in nearby Federal agencies engaged in economic research.

A complete description of the requirements of the degrees in economics and the admission process is available on request from: Director of Graduate Studies in Economics, Department of Economics, University of Maryland, College Park, Maryland 20742.

ECON 401. NATIONAL INCOME ANALYSIS (3)
Prerequisite, ECON 203. Required for undergraduate economics majors. An analysis of national income accounts and the level of national income and employment.

ECON 402. BUSINESS CYCLES (3)
Prerequisite, ECON 430. A study of the causes of depressions and unemployment, cyclical and secular instability, theories of business cycles, and the problem of controlling economic instability. (Almon)

ECON 403. INTERMEDIATE PRICE THEORY (3)
Prerequisite, ECON 203. Required for undergraduate economics majors. An analysis of price and distribution theory with special attention to recent development in the theory of imperfect competition.

ECON 407. CONTEMPORARY ECONOMIC THOUGHT (3)
Prerequisites, ECON 203 and senior standing. Graduate students should take ECON 705. A survey of the development of economic thought since 1900 with special reference to Thorstein Veblen and other institutionalists and the neo-institutionalists such as J. K. Galbraith and Gunnar Myrdal. (Gruchy)

ECON 411. AMERICAN ECONOMIC DEVELOPMENT (3)
Prerequisites, ECON 203 or 205. Long-term trends in the American economy and analysis of the sources of output growth. Technological changes and the diffusion of new technologies. These subjects are discussed in the context of theoretical models. (West)

ECON 415. INTRODUCTION TO ECONOMIC DEVELOPMENT OF UNDERDEVELOPMENT AREAS (3)
Prerequisite, ECON 203 or 205. An analysis of the economic and social characteristics of underdeveloped areas. Recent theories of economic development, policies and planning for development. (Adams, Bennett, Betancourt)

ECON 418. ECONOMIC DEVELOPMENT OF SELECTED AREAS
A. Latin America, B. Asia, C. Africa, Prerequisite, ECON 415. Institutional characteristics of a specific area are discussed and alternate strategies and policies for development are analyzed.

ECON 421. QUANTITATIVE METHODS IN ECONOMICS (3)
Prerequisites, ECON 401, 403. Economic theory as it relates to quantitative methods. Theory of statistical inference. (MacRae, Peterson)

ECON 422. QUANTITATIVE METHODS IN ECONOMICS II (3)
Prerequisites, ECON 401, 403, 421, and 425, or permission of instructor. Formulation, estimation and testing of economic models; theory of identification in linear models, multiple regression and analysis of variance; single-equation problems in econometric work and econometric methods in estimation of multi-equation structures. Examples of current research employing econometric methods. (Betancourt, MacRae, Peterson)

ECON 425. MATHEMATICAL ECONOMICS (3)
Prerequisites, ECON 401 and 403 and one year of college mathematics. A course designed to enable economics majors to understand the simpler aspects of mathematical economics. Those parts of the calculus and algebra required for economic analysis will be presented (MacRae)

ECON 430. MONEY AND BANKING (3)
Prerequisite, ECON 203. Relation of money and credit to economic activity and prices; impact of public policy in financial markets and for goods and services; policies, structure, and functions of the federal reserve system; organization, operation, and functions of the commercial banking system, as related particularly to questions of economic stability and public policy.

ECON 431. THEORY OF MONEY, PRICES AND ACTIVITY (3)
Prerequisite, ECON 430. A theoretical treatment of the influence of money and financial markets on economic activity and prices, and of the effects of monetary policy on the markets for goods and services; the role of money in the Classical and Keynesian macro-systems; topics of theoretical interest in monetary policy formation and implementation.

ECON 440. INTERNATIONAL ECONOMICS (3)
Prerequisite, ECON 203. A descriptive and theoretical analysis of international trade, balance of payments accounts, the mechanism of international economic adjustment, comparative costs, economics of customs unions.

ECON 441. INTERNATIONAL ECONOMIC POLICIES (3)
Prerequisites, ECON 401, 403, and 440. Contemporary balance of payments problems; the international liquidity controversy investment, trade and economic development; evaluation of arguments for protection. (Layher)

ECON 450. INTRODUCTION TO PUBLIC FINANCE (3)
Prerequisites, ECON 201 and 203 or 203 and 205. A study of the role of federal, state and local governments in mobilizing resources to meet public wants; principles and policies of taxation, debt management, and government expenditures and their effects on resource allocation, stabilization of income and prices, income distribution, and economic growth. (Christensen, Singer)

ECON 451. THEORY OF PUBLIC FINANCE (3)
Prerequisites, ECON 450 and 401 or consent of instructor. An economic analysis of the theory and practice of public finance including taxation, debt management, expenditures, and fiscal policy. (McGuire, Singer)

ECON 454. STATE AND LOCAL PUBLIC FINANCE (3)
Prerequisite, ECON 203 or 205. Principles and problems of governmental finance with special reference to state and local jurisductions. Topics to be covered include taxation, expenditures and intergovernmental fiscal relations. (King)

ECON 460. INDUSTRIAL ORGANIZATION (3)
Prerequisite, ECON 203 or 205. Changing structure of the American economy; price policies in different industrial classifications of monopoly and competition in relation to problems of public policy. (O'Connell, Qualls)

ECON 461. ECONOMICS OF AMERICAN INDUSTRIES (3)
Prerequisite, ECON 203 or 205. A study of the technology, economics and geography of representative American industries. (Measday)

ECON 470. LABOR ECONOMICS (3)
Prerequisite, ECON 203 or 205. The historical development and chief characteristics of the American labor movement are first surveyed. Present-day problems are then examined in detail; wage theories, unemployment, social security, labor organization, and collective bargaining. (Knight, Weinstein)

ECON 471. CURRENT PROBLEMS IN LABOR ECONOMICS (3)
Prerequisite, ECON 470. A detailed examination of current problems in labor economics including: labor market and manpower problems, unemployment compensation and social security, wage theories, and productivity analysis. (Knight, Weinsten)

ECON 475. ECONOMICS OF POVERTY AND DISCRIMINATION (3)
Prerequisite, ECON 203 or 205. Topics include the causes of the persistence of low income groups; the relation of poverty to technological change, to economic growth, and to education and training; economic motivations for discrimination; the economic results of discrimination; proposed remedies for poverty and discrimination. (Bergmann, Clague, McLoone, Schiller)

ECON 480. COMPARATIVE ECONOMIC SYSTEMS (3)
Prerequisite, ECON 203 or 205. An investigation of the theory and practice of various types of economic systems. An examination and evaluation of the capitalistic system followed by an analysis of alternative types of economic systems such as Fascism, Socialism and Communism. (Amuzegar, Dodge, Gruchy)

ECON 482. ECONOMICS OF THE SOVIET UNION (3)
Prerequisite, ECON 203 or 205. An analysis of the organization, operating principles and performance of the Soviet economy with attention to the historical and ideological background, planning, resources, industry, agriculture, domestic and foreign

trade, finance, labor, and the structure and growth of national income. (Dodge)

ECON 484. THE ECONOMY OF CHINA (3)
Prerequisite, ECON 203 or 205. Policies and performances of the Chinese economy since 1949. Will begin with a survey of modern China's economic history. Emphasizes the strategies and institutional innovations that the Chinese have adopted to overcome the problems of economic development. Some economic controversies raised during the 'Cultural Revolution' review of the problems and prospects of the present Chinese economy. (Denny)

ECON 486. THE ECONOMICS OF NATIONAL PLANNING (3)
Prerequisite, ECON 203 or 205. An analysis of the principles and practice of economic planning with special reference to the planning problems of West European countries and the United States. (Almon, Gruchy)

ECON 490. SURVEY OF URBAN ECONOMIC PROBLEMS AND POLICIES (3)
Prerequisites, ECON 201, 203 or 205. An introduction to the study of urban economics through the examination of current policy issues. Topics may include suburbanization of jobs and residences, housing and urban renewal, urban transportation, development of new towns, ghetto economic development, problems in services such as education and police. (Straszheim)

ECON 491. REGIONAL AND URBAN ECONOMICS (3)
Prerequisite, ECON 401, or consent of the instructor. Study of the theories, problems and policies of urban and regional economic development. (Harris, King)

ECON 601. MACRO-ECONOMIC ANALYSIS (3)
First semester of a two-semester sequence, 601-602. Topics normally include general equilibrium theory in Classical, Keynesian, and Post-Keynesian treatments; the demand for money; theories of consumption behavior and of inflation. (Aaron, Atkinson, Wonnacott)

ECON 602. ECONOMIC GROWTH AND INSTABILITY (3)
Second semester. A continuation of ECON 601. Major topics include growth and technological change, investment, business cycles, and large empirical macroeconomic models. Also included is material on wages and employment and on international and domestic stability. (Atkinson)

ECON 603. MICRO-ECONOMIC ANALYSIS (3)
This course and its sequel, ECON 604, analyze the usefulness and shortcomings of prices in solving the basic economic problem of allocating scarce resources among alternative uses. The central problem of welfare economics and general equilibrium provides the framework for a detailed analysis of consumption and production theories including linear programming with decisions under uncertainty. An acquaintance with calculus or concurrent enrollment in ECON 621 is presumed. (Clague, Pierce, Ulmer)

ECON 604. ADVANCED MICRO-ECONOMIC ANALYSIS (3)
Prerequisite, ECON 603. A continuation of ECON 603. Theory of capital, interest and wages. Qualifications of the basic welfare theorem caused by noncompetitive market structures, external economies and diseconomies and secondary constraints. Application of price theory to public expenditure decisions, investment in human capital, international trade, and other areas of economics. (Olson, Ulmer)

ECON 605. WELFARE ECONOMICS (3)
Prerequisite, ECON 603. The topics covered include Pareto optimality, social welfare functions, indivisibilities, consumer surplus, output and price policy in public enterprise, and welfare aspects of the theory of public expenditures. (McGuire, Olson)

ECON 606. HISTORY OF ECONOMIC THOUGHT (3)
Prerequisite, ECON 403 or consent of the instructor. A study of the development of economic thought and theories including the Greeks, Romans, Canonists, Mercantilists, Physiocrats, Adam Smith, Malthus, Ricardo. Relation of ideas to economic policy. (Dillard)

ECON 607. ECONOMIC THEORY IN THE NINETEENTH CENTURY (3)
Prerequisite, ECON 606 or consent of the instructor. A study of Nineteenth-Century and Twentieth-Century Schools of economic thought, particularly the Classicists, Neo-Classicists, Austrians, German Historical School, American Economic Thought, the Socialists, and Keynes. (Dillard)

ECON 611. SEMINAR IN AMERICAN ECONOMIC DEVELOPMENT (3)

ECON 613. ORIGINS AND DEVELOPMENT OF CAPITALISM (3)
Studies the transition from feudalism to modern capitalistic economies in Western Europe. Whenever possible, this economic history is analyzed with the aid of tools of modern economics, and in the light of comparisons and contrasts with the less developed areas of the present day. (Olson)

ECON 615. ECONOMIC DEVELOPMENT OF UNDERDEVELOPED AREAS (3)
Prerequisite, ECON 401 and 403. An analysis of the forces contributing to and retarding economic progress in underdeveloped areas, Macro- and micro-economic aspects of development planning and strategy are emphasized. (Adelman, Bennett)

ECON 616. SEMINAR IN ECONOMIC DEVELOPMENT (3)
Prerequisite, ECON 615 or consent of instructor. A continuation of ECON 615. Special emphasis is on the application of economic theory in the institutional setting of a country or area of particular interest to the student. (Adams, Bennett)

ECON 617. MONEY AND FINANCE IN ECONOMIC DEVELOPMENT (3)
Economic theory, strategy and tactics for mobilizing real and financial resources to finance and accelerate economic development. Monetary, fiscal, and tax reform policy and practice by the government sector to design and implement national development plans. (Bennett)

ECON 621. QUANTITATIVE ECONOMICS I (3)
An introduction to the theory and practice of statistical inference. Elements of computer programming and a review of mathematics germane to this and other graduate economics courses are included. (MacRae)

ECON 622. QUANTITATIVE ECONOMICS II (3)
Prerequisite, ECON 621. Techniques of estimating relationships among economic variables. Multiple regression, the analysis of variance and covariance, and techniques for dealing in time series. Further topics in mathematics. (Boorman, MacRae)

ECON 656. PUBLIC SECTOR WORKSHOP (3)
Representative problems in analysis for public decision making: measurement of benefits and costs; incommensurabilities in benefits, and ambiguities in cost; criteria for program and project selection; effects of uncertainty; time horizon considerations; joint costs and multiple benefits; non-quantifiable factors in decision analysis. Examples will be taken from current government programs.

ECON 661. ADVANCED INDUSTRIAL ORGANIZATION (3)
Prerequisite, ECON 401 and 403 or consent of instructor. Analysis of market structure and its relation to market performance. (Qualls)

ECON 662. INDUSTRIAL ORGANIZATION AND PUBLIC POLICY (3)
Prerequisite, ECON 661 or consent of instructor. Analysis of the problems of public policy in regard to the structure, conduct, and performance of industry. Examination of anti-trust policy from the point of view of economic theory. (Qualls)

ECON 671. SEMINAR IN LABOR ECONOMICS (3)
Formal models of labor demand, supply, utilization and price formation. Factors affecting labor supply; the determination of factor shares in an open economy; bargaining models, labor resources, trade union theories as they affect resource allocation. (Weinstein)

ECON 672. SELECTED TOPICS IN LABOR ECONOMICS (3)
The wage-price issue; public policy with respect to unions, labor-management relations, and the labor market; institutional aspects of the American labor movement; manpower development and training. (Knight)

ECON 682. SEMINAR IN ECONOMIC DEVELOPMENT OF THE SOVIET UNION (3)
Prerequisite, ECON 482 or consent of instructor. Measurement and evaluation of Soviet economic growth including interpretation and use of Soviet statistics, measurement of national income, fiscal policies, investment and technological change, planning and economic administration, manpower and wage policies, foreign trade and aid. Selected topics in bloc development and reform. (Dodge)

ECON 686. ECONOMIC GROWTH IN MATURE ECONOMIES (3)
Analysis of policies and problems for achieving stable economic growth in mature economics such as the United States, and the major West European countries. (Gruchy)

ECON 698. SELECTED TOPICS IN ECONOMICS (3)

ECON 705. SEMINAR IN INSTITUTIONAL ECONOMIC THEORY (3)
A study of the recent developments in the field of institutional economic theory in the United States and abroad. (Gruchy)

ECON 706. SEMINAR IN INSTITUTIONAL ECONOMIC THEORY (3) (Gruchy)

ECON 721. ECONOMETRICS I (3)
Special topics in mathematical statistics necessary for understanding econometric theory, with particular emphasis on multivariate analysis. The estimation of simultaneous equation systems, problems involving errors in variables, distributed lags, and spectral analysis. (Almon, Adelman)

ECON 722. SEMINAR IN QUANTITATIVE ECONOMICS (3)
Prerequisite, ECON 622 or consent of instructor. Analysis of data sources for economic research; critical evaluation of previous and current quantitative economic studies; and class discussion and criticism of student research projects. (Almon, Adelman)

ECON 725. ADVANCED MATHEMATICAL ECONOMICS (3)
Optimization techniques such as Lagrangian multipliers and linear programming. Mathematical treatment of general equilibrium, including interindustry analysis, the theory of production, consumption, and welfare. The course assumes a background in calculus and matrix algebra such as provided by ECON 621 and 622. (Almon, Madan)

ECON 726. SEMINAR IN MATHEMATICAL ECONOMICS (3)
Prerequisite, ECON 725. (Almon, Madan)

ECON 731. MONETARY THEORY AND POLICY (3)
An adequate knowledge of micro- and macroeconomics is assumed. Theory of money, financial assets, and economic activity; review of classical, Neo-Classical and Keynesian contribution; emphasis on Post-Keynesian contributions, including those of Tobin, Patinkin, Gurley-Shaw, Friedman, and others. (Meyer)

ECON 732. SEMINAR IN MONETARY THEORY AND POLICY (3)
Prerequisite, ECON 731 or consent of instructor. Theory of the mechanisms through which central banking affects economic activity and prices; formation and implementation of monetary policy; theoretical topics in monetary policy. (Meyer)

ECON 741. ADVANCED INTERNATIONAL ECONOMIC RELATIONS (3)
The international mechanism of adjustment; price, exchange rate, and income changes, comparative costs, factor endowments, and the gains from trade. Commercial policy and the theory of customs unions. (Wonnacott)

ECON 742. SEMINAR IN INTERNATIONAL ECONOMIC RELATIONS (3) (Wonnacott)

ECON 751. ADVANCED THEORY OF PUBLIC FINANCE (3)
Review of utility analysis to include the theory of individual consumer resource allocation and exchange and welfare implications, effects of alternative tax and subsidy techniques upon allocation, exchange, and welfare outcomes. Theories of public goods, their production, exchange and consumption. Principles of benefit-cost analysis for government decisions. (Schultze)

ECON 752. SEMINAR IN PUBLIC FINANCE (3)
Theory of taxation and tax policy, with particular emphasis on income taxation; empirical studies; the burden of the public debt. Research paper by each student to be presented to seminar.
(Aaron, McGuire)

ECON 761. THE ECONOMICS OF TECHNICAL CHANGE (3)
Prerequisite, consent of instructor. Determinants and impact of inventions and innovations. Qualitative and quantitative aspects of technical change both at the micro- and macro-economic levels and under different conditions of economic development.

ECON 775. SEMINAR ON THE ECONOMICS OF POVERTY AND DISCRIMINATION (3)
Prerequisites, ECON 621 and 622. A review of the economic literature in poverty and discrimination. The course will also function as a workshop in which research of the staff and students is presented. (Bergmann)

ECON 776. SEMINAR IN THE ECONOMICS OF HUMAN RESOURCES (3)
Prerequisite, consent of instructor.
(Clague, McLoone)

ECON 791. ADVANCED REGIONAL AND URBAN ECONOMICS (3)
Location theory and spatial distribution of economic activity; application of analytic methods, such as social accounting systems, economic base theory, input-output techniques, and industrial complex analysis to problems of regional development, environmental quality, and natural resource management. (Cumberland)

ECON 792. SEMINAR IN REGIONAL AND URBAN ECONOMICS (3)
Selected topics and techniques in regional and urban economic analysis, including models for economic projections, urban growth, and regional development. (Harris)

ECON 799. MASTER'S THESIS RESEARCH (1-6)

ECON 899. DOCTORAL DISSERTATION RESEARCH (1-6)

ELECTRICAL ENGINEERING PROGRAM

Professor and Chairman: DeClaris
Professors: Chu,[1] Hochuli, Ligomenides, Lin, Newcomb, Reiser,[2] Taylor, Wagner, Weiss [3]
Associate Professors: Basham, Emad, Harger, Kim,[2] Lee, W. Levine, Pugsley, Rao, Simons, Torres, Tretter, Zajac
Assistant Professors: Boston, Ephremides, Friedman, D. Levine, Lieberman, O'Grady, Paez, Rhee, Silio, Zaki

[1] joint appointment with Computer Science
[2] joint appointment with Physics
[3] joint appointment with Institute for Fluid Dynamics and Applied Mathematics

The Electrical Engineering Department offers graduate work leading to the Master of Science with or without thesis and the Doctor of Philosophy degrees with specialization in: a) biomedical engineering, b) circuits, c) communication, d) computers, e) control and f) electrophysics. Each graduate student pursues an individual study program planned in conjunction with his Graduate Advisor and which includes an appropriate sequence of courses and a thesis or scholarly paper.

In Biomedical Engineering, areas of study include neural electrophysiology, transduction and neural coding of sensory events, control of effector organs, muscle contraction and mechanics, instrumental techniques of nerve signal processing and health care systems.

Areas of study in Circuits emphasize the analysis and synthesis of passive and active, linear and nonlinear networks including the design of digital data acquisition systems, optimized FM signal detectors, microwave active circuit synthesis, digital computer circuit design, microminiature integrated circuits and devices, biomedical transductors, computer aided designs and scattering formalisms.

Areas of study in computers are involved in the advancement of basic switching theory, the theory and application of arithmetic coding and self-checking processes, stochastic automata theory, and the design of digital, analog, and hybrid systems for both general and special purposes.

Areas of study in Communication apply the mathematics of random processes and statistical inference, to analysis, and design of communication systems, including investigations of theory and applications in coding theory, optical communications, radar systems, and Walsh function applications.

In Control, areas of study apply the mathematics of dynamical systems, optimization, and random processes to the synthesis and analysis of control systems. Topics included are state realizations, power system optimization, optimal control of large scale systems, control systems with time delay, non-linear systems, fluidic and microminiature systems, systems with shot noise, ecological systems, and air traffic control.

Areas of study in Electrophysics include electromagnetic theory and applications (microwaves and optics, stochastic media, plasma propagation); charged particle dynamics and accelerator design, including high-power microwave engineering applicaitons of relativistic beams, controlled thermonuclear fusion and cyclotron design; quantum electronics (laser technology and non-linear optics); integrated circuits and solid state devices (semiconductor devices and technology); scattering systems.

There are seven up-to-date research laboratories and computational facilities within the department. The Biomedical Laboratory is equipped with instru-

mentation for studying the motor control mechanisms of man and animals. The Laboratory for Charged Particle Studies contains an ion beam facility for source development and ion implantation. The System Simulation Laboratory contains a digital processor core and drum memory with analog hardware and graphics. The Gas Laser Laboratory is devoted to He-Ne and CO_2 lasers while the Solid State Laser Laboratory features a mode-locked Nd glass laser and an injection GaAs laser. The integrated Circuits Laboratory contains a full-line facility capable of producing monolithic, thin-film and MOS structures. The Computational Facility contains conversational and remote-batch terminals to the University's IBM 7094 and UNIVAC 1108 digital computers.

Further details and information on admission, financial aid, and degree requirements can be obtained from the Electrical Engineering Office of Graduate Studies, Area Code 301, 454-4173.

ENEE 402. ADVANCED PULSE TECHNIQUES (3)
Prerequisite: ENEE 314 or ENEE 410 or equivalent. Bistable, monostable, and astable circuits, sweep circuits, synchronization, counting, gates, comparators. Magnetic core circuits, semiconductor and vacuum-tube circuits.

ENEE 403. PULSE TECHNIQUES LABORATORY (1)
Two hours of laboratory per week. Corequisite: ENEE 402 and permission of the instructor. Experiments on switching circuits, bistable, monostable, and astable circuits, sweep circuits, gates, comparators.

ENEE 404. RADIO ENGINEERING (3)
Prerequisite: ENEE 314. Tuned circuit amplifiers, single, double, and stagger tuned circuits; class C amplifiers; frequency multipliers; amplitude modulators and detectors; receiver design and characteristics; frequency modulation; FM transmitters and receivers.

ENEE 405. ADVANCED RADIO ENGINEERING LABORATORY (7)
Two hours of laboratory per week. Corequisite: ENEE 404. Experiments on multiple tuned amplifiers, noise figure measurements, class-C amplifiers, varactors, modulators, proects.

ENEE 406. MATHEMATICAL FOUNDATIONS OF CIRCUIT THEORY (3)
Prerequisites: ENEE 304 and MATH 241, or equivalent. Review of determinants, linear equations, matrix theory, eigenvalues, theory of complex variables, inverse LaPlace transforms. Applications are drawn primarily from circuit analysis.

ENEE 410. ELECTRONIC CIRCUITS (3)
Prerequisite: ENEE 300 or equivalent knowledge of circuit theory or consent of the instructor. This course is intended for students in the physical sciences, and for engineering students requiring additional study of electron circuits. Credit not normally given for this course in an electrical engineering major program. (ENEE 413 may optionally be taken as an associated laboratory). P-n junctions, transistors, vacuum tubes, biasing and operating point stability, switches, large-signal analysis, models, small-signal analysis, frequency response, feedback and multistage amplifiers, pulse and digital circuits.

ENEE 412. TELEMETRY SYSTEMS (3)
Prerequisite: ENEE 314. Selected digital circuits; frequency division multiplexing; FM/AM systems. SSB/FM systems; time division multiplexed systems; pulse amplitude modulation; pulse duration modulation; pulse code modulation; analog to digital converters; multiplexers and DC-commutators.

ENEE 413. ELECTRONICS LABORATORY (2)
Speciality Elective Laboratory. Prerequisite: ENEE 305. 1 lecture and 3 lab hours per week. Provides experience in the specification, design, and testing of basic electronic circuits and practical interconnections. Emphasis on design with discrete solid state and integrated circuit components for both analog and pulse circuits.

ENEE 414. NETWORK ANALYSIS (3)
Specialty Elective Course. Prerequisite: ENEE 304. Network properties: Linearity, reciprocity, etc.; 2-port descriptions and generalization: Y, S, hybrid matrices; description properties: Symmetry, para-unitary, etc.; basic topological analysis; state-space techniques; computer-aided analysis; sensitivity analysis; approximation theory.

ENEE 416. NETWORK SYNTHESIS (3)
Speciality Elective Course. Prerequisite: ENEE 304. Active and passive components, passivity, bounded and positive real, RC properties and synthesis, Brune and Darlington synthesis, transfer-voltage and Y_{21} synthesis, active feedback configurations, image parameter design, computer-aided optimization, synthesis via the embedding concept.

ENEE 417. ADVANCED NETWORK THEORY (3)
Corequisite: ENEE 414 (or consent of instructor). A study of network descriptions for analysis and basic active synthesis. Indefinite and topological formulations, n-port structures and interconnections, active components and descriptions, synthesis using controlled sources, synthesis and analysis via state characterizations. Additional topics from non-linear, distributed parameter, and digital filters.

ENEE 418. PROJECTS IN ELECTRICAL ENGINEERING (1-3)
Hours to be arranged. Prerequisites: Senior standing and permission of the instructor. May be taken for repeated credit up to a total of 4 credits, with the permission of the student's advisor and the instructor. Theoretical and experimental projects.

ENEE 419. APPRENTICESHIP IN ELECTRICAL ENGINEERING (2-3)
Hours to be arranged. Prerequisite, completion of sophomore courses and permission of an apprenticeship director. May be taken for repeated credit up to a total of nine credits. A unique opportunity for experience in experimental research and engineering design. A few highly qualified students will be selected as apprentices in one of the research facilities of the electrical engineering department and will participate in the current research under the supervision of the laboratory director. In the past, apprenticeships have been available in

the following laboratories: biomedical, electron ring accelerator, gas laser, integrated circuits, simulation and computer, and solid state laser.

ENEE 420. COMMUNICATION THEORY (3)
Specialty Elective Course. Prerequisite: ENEE 320. Random signals: elements of random processes, noise, Gaussian process, correlation functions and power spectra, linear operations; optimum receivers, vector wave-form channels, receiver implementation, probability of error performance; efficient signalling: sources, encoding, dimensionality, channel capacity; wave form communication: linear, angle, and pulse modulation.

ENEE 421. INTRODUCTION TO INFORMATION THEORY (3)
Specialty Elective Course. Prerequisite: ENEE 320. Definition of information and entropy; characterization of sources; Kraft and MacMillan inequalities; coding information source; noiseless coding theorem; channels and mutual information; Shannon's coding theorem for noisy channels.

ENEE 425. SIGNAL ANALYSIS, MODULATION AND NOISE (3)
Prerequisites: ENEE 314 and ENEE 320. Signal transmission through networks, transmission in the presence of noise, statistical methods of determining error and transmission effects, modulation schemes.

ENEE 432. ELECTRONICS FOR LIFE SCIENTISTS (3)
Three hours of lecture and two hours of laboratory per week. Prerequisites: College algebra and a physics course, including basic electricity and magnetism. Not accepted for credit in an electrical engineering major program. The concept of an instrumentation system with emphasis upon requirements for transducers, amplifiers, and recording devices, design criteria and circuitry of power supplies amplifiers, and pulse equipment, specific instruments used for biological research, problems of shielding against hum and noise pickup and other interference problems characteristic of biological systems.

ENEE 433. ELECTRONIC INSTRUMENTATION FOR PHYSICAL SCIENCE (3)
Two hours of lecture and two hours of laboratory per week. Prerequisite: ENEE 300 or 306, PHYSICS 271 or equivalent, or consent of instructor. The concept of instrumentation systems from sensor to readout; discussions of transducers, system dynamics, precision and accuracy; measurement of electrical parameters; direct, differential, and potentimetric measurements; bridge measurements, time and frequency measurements, wave-form generation and display.

ENEE 434. INTRODUCTION TO ELECTRICAL PROCESSES IN BIOLOGY AND MEDICINE 1 (3)
Specialty Elective Course. Prerequisite; ENEE 300 or equivalent. Introduction in the generation and processing of bioelectric signals including structure and function of the neuron, neuron models, membrane theory, generation and propagation of nerve impulses, synaptic mechanisms transduction and neural coding and sensory events, central nervous system processing of sensory information and correlated electrical signals, control of effector organs, muscle contraction and mechanics, and analytical and instrumental techniques of nerve signal processing.

ENEE 435. INTRODUCTION TO ELECTRICAL PROCESSES IN BIOLOGY AND MEDICINE II (3)
Specialty elective course. Prerequisite: ENEE 434. Emphasis on the experimental and analytical methods necessary to elucidate peripheral and central nervous system function, activity and information processing; acquisition and analysis of electrocardiograms; electromyograms and electroencephalograms.

ENNE 440. DIGITAL COMPUTER ORGANIZATION (3)
Prerequisite: ENES 243 or CMSC 210 or equivalent. Same as CMSC 410. Introduction; computer elements; parallel adders and subtracters; micro-operations: sequences: computer simulation; organization of a commercially available stored program computer; microprogrammed computers; a large-scale batch-processing system (optional). (Intended for those minoring in computers and for those majoring in Computer Science).

ENNE 442. INTRODUCTION TO COMPUTER-AIDED ANALYSIS AND DESIGN (3)
Prerequisites: ENES 243, ENEE 314. Application of digital computers to solutions of lumped parameter system problems; use of simulators; economic and reliability considerations; investigation and applications of problem oriented programs such as those for circuit analysis, (e.g. CORNAP, JOBSHOP, ECAP, and NASAP.) The use of the computer will be an integral part of the course.

ENEE 443. INTRODUCTION TO COMPUTERS AND COMPUTATION (3)
Prerequisite: ENES 243 or equivalent. Basic structure and organization of digital systems; representation of data, introduction to softwave systems; assembly language; application of computers in engineering and physical systems. Not open for students who have credit in ENEE 250.

ENEE 444. LOGIC DESIGN OF DIGITAL SYSTEMS (3)
Prerequisite: ENEE 250. Review of switching algebra; gates and logic modules; map simplification techniques; multiple-output systems; memory elements and sequential systems; large switching systems; iterative networks; sample designs, computer oriented simplification algorithms; state assignment; partition techniques; sequential system decompositions.

ENEE 445. COMPUTER LABORATORY (2)
Prerequisite: ENEE 305, corequisite: ENEE 444. 1 lecture and 3 lab hours per week. Hardware oriented experiments providing practical experience in the design, construction, and checkout of components and interfaces for digital computers and data transmission systems. Projects include classical designs techniques and applications of current technology.

ENEE 446. COMPUTER ARCHITECTURE (3)
Specialty elective course. Prerequisite: ENEE 444. Digital computer organization; arithmetic hardware;

primary and secondary storage organization; read-only and associative memories; introduction to multi-processor and multi-programming computer systems; interaction of hardware and software.

ENEE 450. INTRODUCTION TO DISCRETE STRUCTURES (3)
Prerequisite: ENES 243 or equivalent. This is the same course as CMSC 340. Review of set algebra including relations, partial ordering and mappings. Algebraic structures including semigroups and groups. Graph theory including trees and weighed graphs. Boolean algebra and propositional logic. Applications of these structures to various areas of computer science and computer engineering.

ENEE 451. INTRODUCTION TO AUTOMATA THEORY (3)
Prerequisite: ENEE 450 or permission of the instructor. An introduction to finite state machines and their properties; properties of regular sets; elementary decomposition results; introduction to Turing machines and computability theory; undecidability propositions; introduction to finite semigroups with application to the decomposition of finite state machines.

ENEE 456. ANALOG AND HYBRID COMPUTERS (3)
Prerequisite: ENEE 314. Programming the analog computer; analog computing components; error analysis, repetitive operation; synthesis of systems using the computer; hybrid computer systems.

ENEE 460. INTRODUCTION TO CONTROL 1 (3)
Prerequisite: ENEE 322. Review of transform analysis and linear algebra, mathematical models for control system components, transient response design, error analysis and design, root locus, frequency response, system design and compensation.

ENEE 461. CONTROL SYSTEMS LABORATORY (2)
Prerequisite: ENEE 305. 1 lecture and 3 lab hours per week. Projects to enhance the student's understanding of feedback control systems and to familiarize him with the characteristics and limitations of real control devices. Students will design, build, and test servomechanisms, and will conduct analog and hybrid computer simulations of control systems.

ENEE 462. INTRODUCTION TO CONTROL II (3)
Prerequisite: ENEE 460 or consent of instructor. Mathematical background, state space analysis, phase plane methods, discrete-time systems, controllability and observability, realization theory, computation and simulation.

ENEE 464. LINEAR SYSTEM THEORY (3)
Prerequisite: ENEE 322. An introduction to the state space theory of linear engineering systems; state variables, Matrix exponential and impulse response. Linear sampled-data systems, discrete systems. Reliability, stability and equivalence. Relation to La-Place transform. Application to circuits, controls, communications and computers.

ENEE 472. TRANSDUCERS AND ELECTRICAL MACHINERY (3)
Prerequisite: ENEE 304. Electromechanical transducers, theory of electromechanical systems, power and wideband transformers, rotating electrical machinery from the theoretical and performance points of view.

ENEE 473. TRANSDUCERS AND ELECTRICAL MACHINERY LABORATORY (1)
Corequisite: ENEE 472. Experiments on transformers, synchronous machines, induction motors, synchros, loudspeakers, other transducers.

ENEE 480. ELECTROMAGNETIC PROPERTIES OF MATERIALS (3)
Prerequisite: ENEE 381. Review of Maxwell's equations, the wave equation; electron dynamics with applications to accelerators; dielectrics; the dielectric model for plasmas, plane waves in magnetoplasmas; introduction to quantum mechanics and quantum statistics; theory of semi-conductors; ferromagnetism and selected topics.

ENEE 481. ANTENNAS (3)
Prerequisite: ENEE 381. Introduction to the concepts of radiation, generalized far field formulas; antenna theorems and fundamentals; antenna arrays, linear and planar arrays; Aperture antennas; Terminal impedance; Propagation.

ENEE 483. ELECTROMAGNETIC MEASUREMENTS LABORATORY (2)
Prerequisites: ENEE 305 and ENEE 380. 1 lecture and 3 lab hours per week. Experiments designed to provide familiarity with a large class of micro-wave and optical components, techniques for interconnecting them into useful systems, and techniques of high frequency and optical measurements.

ENEE 487. PARTICLE ACCELERATORS, PHYSICAL AND ENGINEERING PRINCIPLES (3)
Three hours of lecture per week. Prerequisites: ENEE 380, and PHYS 420, or consent of the instructor. Sources of charged particles; methods of acceleration and focusing of ion beams in electromagnetic fields; basic theory, design, and engineering principles of particle accelerators.

ENEE 488. TOPICS IN ELECTRICAL ENGINEERING (3)
Prerequisite: Permission of the instructor. May be taken for repeated credit up to a total of 6 credits, with the permission of the student's advisor and the instructor.

ENEE 496. PHYSICAL ELECTRONICS OF DEVICES (3)
Three hours of lecture per week. Prerequisite: PHYS 420 and ENEE 480. Introduction to electron and ion optics. Principles of vacuum tubes, klystrons and magnetrons. Conductivity of metals and semiconductors. P-n junction and transistors.

ENEE 601. ACTIVE NETWORK ANALYSIS (3)
Prerequisite, ENEE 406 or equivalent. The complex frequency plane, conventional feedback and sensitivity, theorems for feedback circuits, stability and physical realizability of electrical networks, Nyquist's and Routh's criteria for stability, activity and passivity criteria.

ENEE 602. TRANSIENTS IN LINEAR SYSTEMS (3)
Prerequisite, undergraduate major in electrical or mechanical engineering or physics. Operational cir-

cuit analysis, the Fourier integral, transient analysis of electrical and mechanical systems and electronic circuits by the Laplace transform method.

ENEE 603. TRANSIENTS IN LINEAR SYSTEMS (3)
Prerequisite, undergraduate major in electrical or mechanical engineering or physics. Continuation of ENEE 602.

ENEE 604. ADVANCED ELECTRONIC CIRCUIT DESIGN (3)
Prerequisite, ENEE 312 or consent of the instructor. Comparison of bipolar and field effect transistors, detailed frequency response of single and multistage amplifiers, design of feedback amplifiers, D-C coupling techniques, design of multistage tuned amplifiers.

ENEE 605. GRAPH THEORY AND NETWORK ANALYSIS (3)
Prerequisite, ENEE 600. Linear graph theory as applied to electrical networks, cut sets and tie sets, incidence matrices, trees, branches, and mazes, development of network equations by matrix and index notation, network characteristic equations for natural circuit behavior, single-flow-graph theory and Mason-S rule, stability of active two-part networks.

ENEE 608. GRADUATE SEMINAR (1-3)
Prerequisite, consent of instructor. Every semester regular seminars are held in electrical science and in the six areas of specialization offered by the Electrical Engineering Department. They may be taken, by arrangement with the student's advisor, for repealed credit.

ENEE 620. RANDOM PROCESSES IN COMMUNICATION AND CONTROL (3)
Prerequisite, ENEE 320 or equivalent. Introduction to random processes: characterization, classification, representation; Gaussian and other examples. Linear operations on random processes, stationary processes: covariance function and spectral density. Linear least-square waveform estimation; Wiener-Kolmogoroff filtering, Kalman-Bucy recursive filtering; function space characterization, Nonlinear operations on random processes.

ENEE 621. ESTIMATION AND DETECTION THEORY (3)
Prerequisite, ENEE 620. Estimation of unknown parameters, Cramer-Rao lower bound: optimum (map) demodulation: filtering, amplitude and angle modulation, comparison with conventional systems; statistical decision theory; criteria (Bayes, minimac, Neyman-Pearson, and MAP), simple and composite hypotheses, application to coherent and incoherent signal detection; M-ARY hypotheses, application to uncoded digital communication systems.

ENEE 630. ADVANCED TOPICS — RADAR SIGNALS AND SYSTEMS (3)
Corequisite, ENEE 620. Review of linear systems and signals: Fourier transform representation time—Bandwidth product, resolution, complex representation; maximum signal-to-noise ratio criterion receiver and signal design, radar range equation; statistical detection theory; probability of error performance; statistical estimation theory: unknown parameters, range-Doppler radar, ambiguity problem, asymptotic maximum likelihood estimation and Cramer-Rao lower bound; resolution of multiple objects.

ENEE 633. MODELING OF NEUROPHYSIOLOGICAL SYSTEMS AND APPLICATIONS (3)
Modeling of neurophysiological systems with particular reference to visual and musclar functions. Models of pupilary light reflexes, eye position, and motor systems operative in animals and man; analysis of visual system processing of sensory information: models of proprioceptors, muscles and motor reflexes: applications of these models in the design of sensory and motor aids for the handicapped.

ENEE 634. NEURAL NETS, SYSTEMS AND SIGNALS (3)
Analysis of neurons and small neural nets and systems; electronic, compartmental and computer models: models of higher neural structures including cerebellum and cerebral cortex; signal recording and analysis techniques. quantitative information aspects, interpretation of neural spike trains.

ENEE 640. ARITHMETIC AND CODING ASPECTS OF DIGITAL COMPUTERS (3)
Prerequisite, ENEE 440 or 446 or permission of the instructor. Digital logic design aspects; sequential circuits; computer number systems; arithmetic codes for error correction; residue number theory; arithmetic unit design; fault detection and correction circuits.

ENEE 646. DIGITAL COMPUTER DESIGN (3)
Prerequisite, ENEE 446. Introduction to design techniques for digital computers; digital arithmetic; logic circuits; digital memories; design of computer elements; arithmetic unit; and control unit. A simple digital computer will be designed.

ENEE 648. ADVANCED TOPICS IN ELECTRICAL ENGINEERING (3)
Every semester courses intended for high degree of specialization are offered by visiting or regular electrical engineering faculty members in two or more of the areas listed in 488. The student should check with the electrical engineering office of graduate studies for a list and the description of the topics offered currently.

ENEE 651. CODING THEORY AND APPLICATIONS (3)
Prerequisite, ENEE 450 and some knowledge of logic of switching systems. Introduction to coding and brief review of modern algebra; theory of linear codes; decoding; Hamming, cyclic and Bose-Chaudhuri codes; error-checking codes for arithmetic; An + B type codes: residue checks; practical self checking arithmetic units; simple automatic fault diagnosing techniques.

ENEE 652. AUTOMATA THEORY (3)
Prerequisite, ENEE 421 or CMSC 640. This is the same course as CMSC 740. Introduction to the theory of abstract mathematical machines; structural and behavioral classification of automata: finite-state automata; theory of regular sets; pushdown automata; linear-bounded automata; finite

transducers; Turing machines; universal Turing machines.

ENEE 654. COMBINATORIAL SWITCHING THEORY (3)
Prerequisites, ENEE 450 and ENEE 444. Application of algebraic techniques to combinatorial switching networks; multivalued systems; symmetries and their use; optimization algorithms; heuristic techniques; majority and threshold logic; function decomposition; cellular cascades.

ENEE 655. STRUCTURE THEORY OF MACHINES (3)
Prerequisites. ENEE 450 and ENEE 444. Machine realizations; partitions and the substitution property; pair algebras and applications; variable dependence; decomposition; loop-free structures; set system decompositions; semigroup realizations.

ENEE 657. SIMULATION OF DYNAMIC SYSTEMS (3)
Prerequisite, ENEE 443. Mechanistic methods for differential equation solution; application of analog or hybrid computers and digital differential analyzers for that purpose; design and structure of languages for digital-analog simulation on a general purpose digital computer; MIMIC languages and examples of its use. Class will run simulation programs on a large-scale computer.

ENEE 660. CONTROL SYSTEM ANALYSIS AND SYNTHESIS (3)
Two lectures per week. Prerequisites, undergraduate automatic control theory background. Linear control systems analysis and synthesis using time and frequency domain techniques; flow graphs, error coefficients, sensitivity, stability, compensation to meet specifications, introduction to sampled data systems. (Same as ENME 602)

ENEE 661. NON-LINEAR AND ADAPTIVE CONTROL SYSTEMS (3)
Two lectures per week. Prerequisite, ENEE 660, ENME 602 or equivalent. Approximate analysis of nonlinear systems using series, perturbation, and linearization techniques; introduction to state space formulation of differential equations; systems with Stochastic inputs; stability, introduction to optimum switched systems; adaptive control systems. (Same as ENME 603).

ENEE 662. SAMPLED-DATA CONTROL SYSTEMS (3)
Prerequisite, undergraduate or graduate preparations in linear feedback control theory. Z-transform and modified Z-transform method of analysis, root-locus and frequency-response methods of analysis, discrete and continuous compensation, analysis with finite pulse width, digital control systems.

ENEE 663. SYSTEM THEORY (3)
Modeling of systems, abstract definition of state, linearity and its implications, linear differential systems, controllability and observability, impulse, transfer functions, realization theory, nonlinear differential systems, definitions of stability, Lyapunov stability theory, the Lur'e problem and Popov condition, input/output stability.

ENEE 664. OPTIMIZATION AND CONTROL (3)
Prerequisite, ENEE 760. Calculus of variations, direct methods of optimization, Euler-Lagrange equations, inequality constraint, maximum principle, Hamilton-Jacobi theory, dynamic programming, adaptive and Stochastic control, filtering theory.

ENEE 680. ELECTROMAGNETIC THEORY (3)
Prerequisite, ENEE 381 or equivalent. Theoretical analysis and engineering applications of Maxwell's Equations. Boundary value problems of electrostatics and magnetostatics.

ENEE 681. ELECTROMAGNETIC THEORY II (3)
Prerequisite, ENEE 381 or equivalent. Continuation of ENEE 680. Theoretical analysis and engineering applications of Maxwell's Equations. The homogeneous wave equation. Plane wave propagation. The interaction of plane waves and material media. Retarded potentials. The Hertz potential. Simple radiating systems. Relativisitic covariance of Maxwell's Equations.

ENEE 683. MATHEMATICS FOR ELECTROMAGNETISM (3)
Prerequisite, undergraduate preparation in electromagnetic theory and advanced calculus. Tensors and curvilinear coordinates, partial differential equations of electrostatics and electrodynamics, functions, integral equations, and calculus variations as applied to electromagnetism.

ENEE 686. CHARGED PARTICLE DYNAMICS, ELECTRON AND ION BEAMS (3)
Three hours per week. Prerequisite, consent of instructor. General principles of single-particle dynamics; mapping of the electric and magnetic fields; equation of motion and methods of solution; production and control of charge particle beams; electron optics; Liouville's Theorem; space charge effects in high current beams; design principles of special electron and ion beam devices.

ENEE 690. QUANTUM AND WAVE PHENOMENA WITH ELECTRICAL APPLICATION (3)
Two lectures per week. Prerequisite, ENEE 381 and ENEE 382 or equivalent. Introduction of quantum and wave phenomena from an electrical engineering points of view. Topics included: general principles of quantum mechanics, operator algebra, the microwave resonant cavity and the analogous potential well problem, harmonic oscillator, hydrogenic atom. Perturbation method applied to the transmission line and potential well problems. Periodically loaded transmission line and Kronig-Penny model of band theory.

ENEE 696. INTEGRATED AND MICROWAVE ELECTRONICS (3)
Prerequisite, ENEE 310. Registration in ENEE 793 recommended. Active and passive elements used in semiconductor structures. Design application of linear and digital integrated circuits.

ENEE 697. SEMICONDUCTOR DEVICES AND TECHNOLOGY (3)
Prerequisite, ENEE 496 or equivalent. Registration in ENEE 793 recommended. The principles, structures and characteristics of semiconductor devices.

Technology and fabrication of semiconductor devices.

ENEE 700. NETWORK SYNTHESIS (3)
Prerequisite, ENEE 605 or equivalent. Design of driving-point and transfer impedance functions with emphasis of the transfer loss and phase of minimum-phase networks, flow diagrams, physical network characteristics, including relations existing between the real and imaginary components of network functions, modern methods of network synthesis.

ENEE 701. NETWORK SYNTHESIS (3)
Prerequisite, ENEE 700 or equivalent. Design of driving-point and transfer impedance functions with emphasis on the transfer loss and phase of minimum-phase networks, flow diagrams, physical network characteristics, including relations existing between the real and imaginary components of network functions, modern methods of network synthesis.

ENEE 703. SEMICONDUCTOR DEVICE MODELS (3)
Prerequisite, ENEE 605 or equivalent. Single-frequency models for transistors; small-signal and wide-band models for general non-reciprocal devices, hybrid-Pi and Tee models for transistors; relationship of models to transistor physics; synthesis of wide-band models from terminal behavior, computer utilization of models for other semiconductor devices.

ENEE 707. APPLICATIONS OF TENSOR ANALYSIS (3)
Prerequisite, ENEE 600 or 602. The mathematical background of tensor notation, which is applicable to electrical engineering problems. Applications of tensor analysis to electric circuit theory and to field theory.

ENEE 721. INFORMATION THEORY (3)
Corequisite, ENEE 620. Prerequisite, STAT 400 or equivalent. Information measure. entropy, mutual information; source encoding; noiseless coding theorem; noisy coding theorem; exponential error bounds; introduction to probabilistic error correcting codes, block and convolutional codes and error bounds; channels with memory; continuous channels; rate distortion function.

ENEE 722. CODING THEORY (3)
Prerequisite, ENEE 721. Algebraic burst and random error correcting codes, convolutional encoding and sequential decoding, threshold decording, concatenated codes, P-N sequences, arithmetic codes.

ENEE 728. ADVANCED TOPICS IN COMMUNICATION THEORY (3)
Topics selected, as announced, from advanced communication theory and its applications.

ENEE 730. ADVANCED TOPICS — RADAR SIGNALS AND SYSTEMS (3)
Prerequisite, ENEE 620 or equivalent. The theory of imaging radar systems. Classifications, resolution mechanisms, and principles. System design for additive noise: effects of ambiguity, multiplicative noise, motion errors, nonlinearities, and scattering mechanism. System design for ambiguity and multiplicative noise. Optical processing. Application to synthetic aperture, astronomical, and Hologram radar.

ENEE 746. DIGITAL SYSTEMS ENGINEERING (3)
Prerequisite, ENEE 646. Systems aspects of digital-computer-based systems; data flow analysis; system organization; control languages; consoles and displays; remote terminals; software-hardware tradeoff; system evaluation; case studies from selected applications areas such as data acquisition and reduction information storage, or the like.

ENEE 748. TOPICS IN COMPUTER DESIGN (1-3)
Prerequisite, permission of the instructor. Such topics as computer arithmetic, computer reliability, and threshold logic will be considered. May be taken for repeated credit.

ENEE 760. MATHEMATICS OF OPTIMIZATION (3)
Prerequisite, course in advanced calculus or real analysis. Introduction to functional analysis with emphasis on applications to system theory and optimization. Topics covered are linear spaces and operators. Hilbert and Banach spaces. Baire Category Theorem. Hahn-Banach Theorem, principle of uniform boundedness, duality.

ENEE 769. ADVANCED TOPICS IN CONTROL THEORY (3)
Topics selected, as announced, from advanced control theory and its applications.

ENEE 780. MICROWAVE ENGINEERING (3)
Prerequisite, ENEE 681. Mathematical methods for the solution of the wave equation, transmission lines and waveguides, selected topics in the theory of waveguide structures, surface guides and artificial dielectrics.

ENEE 781. OPTICAL ENGINEERING (3)
Fourier analysis in two dimensions, Diffraction Theory, optical imaging systems, spatial filtering, holography.

ENEE 782. RADIO WAVE PROPAGATION (3)
Two lectures per week. Prerequisite, ENEE 681. General solutions of Maxwell's Equations, geometrical optics approximations, propagation above a plane earth, effects of surface irregularities and stratified atmospheres, scattering by turbulence.

ENEE 783. RADIO WAVE PROPAGATION (3)
Two lectures per week. Prerequisite, ENEE 782. Continuation of ENEE 782.

ENEE 784. ANTENNA THEORY (3)
Two lectures per week. Prerequisite, ENEE 681 or equivalent. Review of Maxwell's Equations; radiative networks; linear antennas; antenna arrays; aperture antennas; advanced topics.

ENEE 790. QUANTUM ELECTRONICS 1 (3)
Two lectures per week. Prerequisite, a knowledge of quantum mechanics and electromagnetic theory. Spontaneous emission, interaction of radiation and matter, lasers, optical resonators, the gas, solid and semi-conductor lasers, electrooptical effect, propagation in anisotropic media and light modulation.

ENEE 791. QUANTUM ELECTRONICS II (3)
Nonlinear optical effects and devices, tunable co-

herent light sources—optical parametric oscillator, frequency conversion and dye laser. Ultrashort pulse generation and measurement, stimulated Raman effect, and applications, interaction of acoustic and optical waves, and holography.

ENEE 793. SOLID STATE ELECTRONICS (3)
Prerequisite, a graduate course in quantum mechanics or consent of instructor. Properties of crystals; energy bands; electron transport theory; conductivity and Hall effect; statistical distributions; Fermi level; impurities; non-equilibrium carrier distributions; normal modes of vibration; effects of high electric fields; P-N junction theory, avalanche breakdown; tunneling phenomena; surface properties.

ENEE 799. MASTER'S THESIS RESEARCH (1-6)

ENEE 899. DOCTORAL DISSERTATION RESEARCH (1-8)

ENGINEERING MATERIALS PROGRAM

Associate Professor and Acting Chairman: Spain (Chem. Eng.)
Professors: Armstrong (Mech. Eng.), Arsenault, (Chem. Eng.), Marcinkowski (Mech. Eng.) and Skolnick (Chem. Eng.)
Associate Professor: Bolsaitis (Chem. Eng.)

The Engineering Materials program has as its primary objective the maintenance and extension of the ever increasing degree of engineering sophistication. The courses and research programs strive to create an atmosphere of originality and creativity that prepares the student for the engineering leadership of tomorrow.

An individual plan of graduate study compatible with the student's interests and background is established between the student, his advisor, and the department heads. The Engineering Materials program is interdisciplinary between Chemical and Mechanical Engineering. Special areas of concentration include diffraction, dislocation and mechanical behavior of materials, x-ray and electron microscopic techniques, electronic and magnetic behavior of materials, and the chemical physics of materials.

The programs leading to the M.S. and Ph.D. degrees are open to qualified students holding the B.S. degree. Admission may be granted to students with degrees in any of the engineering and science areas from accredited programs. In some cases it may be necessary to require courses to fulfill the background. The general regulations of the Graduate School apply in reviewing applications.

The candidate for the M.S. degree has the choice of following a plan of study with thesis or without thesis. The equivalent of at least three years of full-time study beyond the B.S. degree is required for the Ph.D. degree. All students seeking graduate degrees in Engineering Materials must enroll in ENMA 650, 660 and 671. In addition to the general rules of the Graduate School certain special degree requirements are set forth by the Departments in their departmental publications.

Special facilities available for graduate study in Engineering Materials are coordinated through the Center for Materials Research, the Laboratory for Radiation and Polymer Science, the Laboratory for High Pressure Science and various central facilities. Special equipment available includes a scanning electron microscope, x-ray diffraction equipment, crystal growing, sample preparation and mechanical testing facilities and high pressure and cryogenic equipment.

Information is available from the Chairman, Engineering Materials Program, University of Maryland· College Park, Maryland 20742.

ENMA 462. DEFORMATION OF ENGINEERING MATERIALS(3)
Prerequisites, ENES 230 or consent of instructor. Relationship of structure to the mechanical properties of materials. Elastic and plastic deformation, microscopic yield criteria, state of stress and ductility. Elements of dislocation theory, work hardening, alloy strengthening, creep, and fracture in terms of dislocation theory.

ENMA 463. CHEMICAL, LIQUID AND POWDER PROCESSING OF ENGINEERING MATERIALS (3)
Prerequisites, ENES 230 or consent of instructor. Methods and processes used in the production of primary metals. The detailed basic principles of beneficiation processes, pyrometallurgy, hydrometallurgy, electrometallurgy, vapor phase processing and electroplating. Liquid metal processing including casting, welding, brazing and soldering. Powder processing and sintering. Shapes and structures produced in the above processes.

ENMA 464. ENVIRONMENTAL EFFECTS ON MATERIALS (3)
Prerequisites, ENES 230 or consent of instructor. Introduction to the phenomena associated with the resistance of materials to damage under severe environmental conditions. Oxidation, corrosion, stress corrosion, corrosion fatigue and radiation damage are examined from the point of view of mechanism and influence on the properties of materials. Methods of corrosion protection and criteria for selection of materials for use in radiation environments.

ENMA 470. STRUCTURE AND PROPERTIES OF ENGINEERING MATERIALS (3)
A comprehensive survey of the atomic and electronic structure of solids with emphasis on the relationship of structure to the physical and mechanical properties.

ENMA 471. PHYSICAL CHEMISTRY OF ENGINEERING MATERIALS (3)
Equilibrium multicomponent systems and relationship to the phase diagram. Thermodynamics of polycrystalline and polyphase materials. Diffusion in solids, kinetics of reactions in solids.

ENMA 472. TECHNOLOGY OF ENGINEERING MATERIALS (3)
Relationship of properties of solids to their engineering applications. Criteria for the choice of materials for electronic, mechanical and chemical properties. Particular emphasis on the relationships between structure of the solid and its potential engineering application.

ENMA 473. PROCESSING OF ENGINEERING MATERIALS (3)
The effect of processing on the structure of engineering materials. Processes considered include refining, melting and solidification, purification by zone refining, vapor phase processing, mechanical working and heat treatments.

ENMA 650. STRUCTURE OF ENGINEERING MATERIALS (3)
Prerequisite, ENMA 470 or equivalent. The structural aspects of crystalline and amorphous solids and relationships to bonding types. Point and space groups. Summary of diffraction theory and practice. The reciprocal lattice. Relationships of the microscopically measured properties to crystal symmetry. Structural aspects of defects in crystalline solids.

ENMA 651. ELECTRONIC STRUCTURE OF ENGINEERING MATERIALS (3)
Prerequisite, ENMA 650. Description of electronic behavior in engineering solids. Behavior of conductors, semiconductors and insulators in electrical fields. Thermal, magnetic and optical properties of engineering solids.

ENMA 659. SPECIAL TOPICS IN STRUCTURE OF ENGINEERING MATERIALS (3)
Prerequisite, consent of instructor.

ENMA 660. CHEMICAL PHYSICS OF ENGINEERING MATERIALS (3)
Prerequisite, thermodynamics and statistical mechanics of engineering solids. Cohesion, thermodynamic properties. Theory of solid solutions. Thermodynamics of mechanical, electrical, and magnetic phenomena in solids. Chemical thermodynamics, phase transitions and thermodynamic properties of polycrystalline and polyphase materials. Thermodynamics of defects in solids.

ENMA 661. KINETICS OF REACTIONS IN MATERIALS (3)
Prerequisite, ENMA 660. The theory of thermally activated processes in solids as applied to diffusion, nucleation and interface motion. Cooperative and diffusionless transformations. Applications selected from processes such as allotropic transformations, precipitation, martensite formation, solidification, ordering, and corrosion.

ENMA 669. SPECIAL TOPICS IN THE CHEMICAL PHYSICS OF MATERIALS (3)
Prerequisite, consent of instructor.

ENMA 670 RHEOLOGY OF ENGINEERING MATERIALS (3)
Prerequisite, consent of instructor. Mechanical behavior with emphasis on the continuum point of view and its relationship to structural types. Elasticity, viscoelasticity, anelasticity and plasticity of single phase and multiphase materials.

ENMA 671. DISLOCATIONS IN CRYSTALLINE MATERIALS (3)
Prerequisite, ENMA 650. The nature and interactions of defects in crystalline solids, with primary emphasis on dislocations. The elastic and electric fields associated with dislocations. Effects of imperfections on mechanical and physical properties.

ENMA 672. MECHANICAL PROPERTIES OF ENGINEERING MATERIALS (3)
Prerequisite, ENMA 671. The mechanical properties of single crystals, polycrystalline and polyphase materials. Yield strength, work hardening, fracture, fatigue and creep are considered in terms of fundamental material properties.

ENMA 679. SPECIAL TOPICS IN THE MECHANICAL BEHAVIOR OF MATERIALS (3)
Prerequisite, consent of instructor.

ENMA 680. EXPERIMENTAL METHODS IN MATERIALS SCIENCE (3)
Methods of measuring the structural aspects of materials. Optical and electron microscopy. Microscopic analytical techniques. Resonance methods. Electrical, optical and magnetic measurement techniques. Thermodynamic methods.

ENMA 681. DIFFRACTION TECHNIQUES IN MATERIALS SCIENCE (3)
Prerequisite, ENMA 650. Theory of diffraction of electrons, neutrons and x-rays. Strong emphasis on diffraction methods as applied to the study of defects in solids. Short range order, thermal vibrations, stacking faults, microstrain.

ENMA 689. SPECIAL TOPICS IN EXPERIMENTAL TECHNIQUES IN MATERIALS SCIENCE (3)
Prerequisite, consent of instructor.

ENMA 690. POLYMERIC ENGINEERING MATERIALS (3)
Prerequisite, ENMA 650 or consent of instructor. A comprehensive summary of the fundamentals of particular interest in the science and applications of polymers, Polymer single crystals, transformations in polymers, fabrication of polymers as to shape and internal structure.

ENMA 691. SPECIAL TOPICS IN ENGINEERING MATERIALS (3)
Prerequisite, consent of instructor.

ENMA 697. SEMINAR IN ENGINEERING MATERIALS (1)

ENMA 698. SPECIAL PROBLEMS IN ENGINEERING MATERIALS (1-16)

ENMA 799. MASTER'S THESIS RESEARCH (1-6)

ENMA 899. DOCTORAL THESIS RESEARCH (1-8)

ENGINEERING SCIENCE COURSES

ENES 401. TECHNOLOGICAL ASSESSMENT (3)
Prerequisite, senior standing or consent of instructor. Analysis of methods of assessing technology in terms of goals and resources. Public and private constraints, changes in objectives and organization. Applications to engineering technology.

ENES 473. PRINCIPLES OF HIGHWAY AND TRAFFIC ENGINEERING (3)
Prerequisite: Permission of instructor. This course is designed to assist the non-engineer in understanding highway transportation systems. A survey of the fundamentals of traffic characteristics and operations. Study of the methods and imple-

mentation of traffic control and regulation. An examination of highway design procedures, and the role of traffic engineering in transportation systems safety improvements.

ENGLISH LANGUAGE AND LITERATURE PROGRAM

Professor and Chairman: Kenny
Professors: Bode, Bryer, Fleming, Freedman, Gravely, Hovey, Isaacs, Lawson, Lutwack, Manning, McManaway, Mish, Murphy, Myers, Panichas, Perloff, Russell, Salamanca, Schoeck, Whittemore
Associate Professors: Barnes, Barry, Birdsall, Brown, Cooper, Fry, Greenwood, G. Hamilton, Holton, Houppert, Howard, Jellema, Kenny, Kinnaird, Kleine, Miller, Peterson, Portz, Smith, Thorberg, Vitzthum, Ward, Wilson
Assistant Professors: Cate, Rutherford, Steinberg, Swigger, Van Egmond, Weigant

The Department of English offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Areas of specialization for the MA and PhD include: English literature, American literature, and folklore. In addition, candidates for the MA degree may specialize in creative writing, in linguistics, and in teaching English as a foreign language.

Departmental requirements for the degree of Master of Arts include: (1) ENGL 601; (2) three credits from the following: ENGL 482, 483, 484, 485, 486; (3) six credits in the ENGL 620 series; and (4) six credits of seminars. Candidates have a non-thesis option under which they take 30 credits, submit a substantial seminar paper for deposit, and pass a three-hour comprehensive examination.

Departmental requirements for the degree of Doctor of Philosophy include: (1) a foreign language requirement; (2) at least three hours of linguistics; (3) a comprehensive written examination on three fields (dissertation field and those immediately before and after it) which may be taken with permission after nine hours beyond the Master of Arts and must be taken upon the completion of 30 hours.

ENGL 401. ENGLISH MEDIEVAL LITERATURE IN TRANSLATION (3)
(Birdsall, Herman, Isaacs, Rutherford)

ENGL 402. CHAUCER (3)
(Gallick, Isaacs, Rutherford, Steinberg)

ENGL 403. SHAKESPEARE (3)
Early period: histories and comedies.
(Barry, D. Hamilton, McManaway)

ENGL 404. SHAKESPEARE (3)
Late periods: tragedies and romances.
(Barry, D. Hamilton, McManaway)

ENGL 405. THE MAJOR WORKS OF SHAKESPEARE (3)
Students who have credit for ENGL 403 or 404 cannot receive credit for ENGL 405.
(Cooper, Houppert, Kimble, Levinson, Schoeck, Widmann)

ENGL 407. LITERATURE OF THE RENAISSANCE (3)
(D. Hamilton, Houppert)

ENGL 410. EDMUND SPENSER (3) (Cooper)

ENGL 411. LITERATURE OF THE RENAISSANCE (3)
(G. Hamilton, Houppert)

ENGL 412. LITERATURE OF THE SEVENTEENTH CENTURY, 1600-1660 (3)
(G. Hamilton, Mish, Murphy, Wilson)

ENGL 414. MILTON (3)
(Freedman, G. Hamilton, Murphy, Wilson)

ENGL 415. LITERATURE OF THE SEVENTEENTH CENTURY, 1660-1700 (3) (Wilson)

ENGL 416. LITERATURE OF THE EIGHTEENTH CENTURY (3)
Age of Pope and Swift. (Kenny, Myers, Tyson)

ENGL 417. LITERATURE OF THE EIGHTEENTH CENTURY (3)
Age of Johnson and the Preromantics.
(Howard, Kenny, Myers, Tyson)

ENGL 418, 419. MAJOR BRITISH WRITERS (3, 3)
Two writers studied intensively each semester.

ENGL 420. LITERATURE OF THE ROMANTIC PERIOD (3)
First generation: Blake, Wordsworth, Coleridge, et al.
(Howard, Kenny, Myers, Tyson)

ENGL 421. LITERATURE OF THE ROMANTIC PERIOD (3)
Second generation: Keats, Shelley, Byron, et al.
(Howard, Kinnaird, G. Smith)

ENGL 422. LITERATURE OF THE VICTORIAN PERIOD (3)
Early years. (Brown, Cate, Kenny, Peterson)

ENGL 423. LITERATURE OF THE VICTORIAN PERIOD (3)
Middle years. (Brown, Cate, Kenny, Peterson)

ENGL 424. LATE VICTORIAN AND EDWARDIAN LITERATURE (3)
A study of the literary movements and techniques which effected the transition from Victorian to modern literature. (Cate, Peterson)

ENGL 425. MODERN BRITISH LITERATURE (3)
An historical survey of the major writers and literary movements in English prose and poetry since 1900.
(Cate, Sewell, Russell)

ENGL 430. AMERICAN LITERATURE, BEGINNING TO 1810, THE COLONIAL AND FEDERAL PERIODS (3)
(Vitzthum, Weigant)

ENGL 431. AMERICAN LITERATURE, 1810 TO 1865. THE AMERICAN RENAISSANCE (3)
(Manning, Martin, Vitzhum, Weigant)

ENGL 432. AMERICAN LITERATURE· 1865 TO 1914, REALISM AND NATURALISM (3)
(Dunn, Gravely, Thorberg)

ENGL 433. AMERICAN LITERATURE, 1914 TO THE PRESENT, THE MODERN PERIOD (3)
(Holton, Lawson, Moore, Walt)

ENGL 434. AMERICAN DRAMA (3) (Barry, Bryer)

ENGL 435. AMERICAN POETRY — BEGINNING TO THE PRESENT (3) (Holton, Van Egmond)

ENGL 436. THE LITERATURE OF AMERICAN DEMOCRACY (3) (Barnes)

ENGL 437. CONTEMPORARY AMERICAN LITERATURE (3)
A survey of the poetry, prose, and drama written in America in the last decade. (Moore)

ENGL 438, 439. MAJOR AMERICAN WRITERS (3, 3)
Two writers studied intensively each semester.

ENGL 440. THE NOVEL IN AMERICA TO 1910 (3) (Dunn, Hovey, Thorberg)

ENGL 441. THE NOVEL IN AMERICA SINCE 1910 (3) (Dunn, Hovey, Thorberg)

ENGL 442. LITERATURE OF THE SOUTH (3)
A historical survey, from eighteenth-century beginnings to the present. (Lawson, Moore)

ENGL 443. AFRO-AMERICAN LITERATURE (3)
An examination of the literary expression of the Negro in the United States, from its beginning to the present. (Coleman, Kelly, Naughton)

ENGL 445. MODERN POETRY (3)
(Fleming, Jellema, Perloff, Van Egmond, Whittemore)

ENGL 449. PLAYWRITING (3) (Fleming)

ENGL 450. ELIZABETHAN AND JACOBEAN DRAMA (3)
Beginnings to Marlowe. (Barry, D. Hamilton)

ENGL 451. ELIZABETHAN AND JACOBEAN DRAMA (3)
Jonson to Webster. (Barry, D. Hamilton)

ENGL 452. ENGLISH DRAMA FROM 1660 TO 1800 (3) (Kenny)

ENGL 453. LITERARY CRITICISM (3) (Lutwack, Trousdale)

ENGL 454. MODERN DRAMA (3) (Barry, Bryer, Freedman, Kimble)

ENGL 455. THE ENGLISH NOVEL (3)
Eighteenth Century. (Kenny, Kleine, Peterson, Ward)

ENGL 456. THE ENGLISH NOVEL (3)
Nineteenth Century. (Kenny, Kleine, Peterson, Ward)

ENGL 457. THE MODERN NOVEL (3)
(Holton, Lawson, Panichas, Perloff, Rowe, Russell)

ENGL 460. INTRODUCTION TO FOLKLORE (3) (Birdsall, Cothran, Fry)

ENGL 461. FOLK NARRATIVE (3)
Studies in legend, tale and myth. Prerequisite, ENGL 460. (Birdsall)

ENGL 462. FOLKSONG AND BALLAD (3)
Prerequisite, ENGL 460. (Glazer)

ENGL 463. AMERICAN FOLKLORE (3)
Prerequisite, ENGL 460. An examination of American folklore in terms of history and regional folk cultures. Exploration of collections of folklore from various areas to reveal the difference in regional and ethnic groups as witnessed in their oral and literary traditions. (Fry)

ENGL 464. AFRO-AMERICAN FOLKLORE AND CULTURE (3)
An examination of the culture of the Negro in the United States in terms of history (antebellum to the present) and social changes (rural to urban). Exploration of aspects of Negro culture and history via oral and literary traditions and life histories. (Fry)

ENGL 465. URBAN FOLKLORE (3)
Prerequisite, ENGL 460. An examination of the folklore currently originating in white, urban, American culture. (Birdsall)

ENGL 470. HONORS CONFERENCE AND READING (1)
Prerequisite, candidacy for honors in English. Candidates will take ENGL 470 in their junior year and ENGL 471 in their senior year. (Manning)

ENGL 471. HONORS CONFERENCE AND READING (1)
Prerequisite, candidacy for honors in English. Candidates will take ENGL 470 in their junior year and ENGL 471 in their senior year. (Manning)

ENGL 472. INDEPENDENT RESEARCH IN ENGLISH (1-3)
This course is designed to provide qualified majors in English an opportunity to pursue specific English readings under the supervision of a member of the department. Restricted to undergraduates.

ENGL 473. SENIOR PROSEMINAR IN LITERATURE (3)
Open only to seniors. Required of candidates for honors and strongly recommended to those who plan to do graduate work. Individual reading assignments; term paper. (Manning)

ENGL 479. SELECTED TOPICS IN ENGLISH AND AMERICAN LITERATURE (3)

ENGL 481. INTRODUCTION TO ENGLISH GRAMMAR (3)
A brief review of traditional English grammar and an introduction to structural grammar, including phonology, morphology and syntax. (James, Nutku)

ENGL 482. HISTORY OF THE ENGLISH LANGUAGE (3) (Birdsall, Herman, James, Nutku)

ENGL 483. AMERICAN ENGLISH (3) (Miller)

ENGL 484. ADVANCED ENGLISH GRAMMAR (3)
Credit may not be granted in both ENGL 484 and LING 402. (James, Miller)

ENGL 485. ADVANCED ENGLISH STRUCTURE (3) (Miller)

ENGL 486. OLD ENGLISH (3) (Rutherford)

ENGL 493. ADVANCED EXPOSITORY WRITING (3) (Beauchamp, Herman, Stevenson, Townsend, Trousdale, Walt)

ENGL 498. CREATIVE WRITING (3)
(Fleming, Holton, Jellema, Salamanca, Van Egmond)

ENGL 499. ADVANCED CREATIVE WRITING (3) (Fleming, Jellema, Salamanca, Whittemore)

ENGL 601. BIBLIOGRAPHY AND METHODS (3)
(Bryer, Cooper, G. Smith, Steinberg, Van Egmond, Widmann)

ENGL 602. MIDDLE ENGLISH (3) (Steinberg)

ENGL 603. ENGLISH LANGUAGE — OLD ENGLISH TO EARLY MODERN ENGLISH (3)
(Isaacs, Rutherford, Steinberg)

ENGL 620. SPECIAL STUDIES IN ENGLISH LITERATURE — THE MEDIEVAL PERIOD TO 1500 (3)
(Birdsall)

ENGL 621. SPECIAL STUDIES IN ENGLISH LITERATURE — RENAISSANCE LITERATURE (3)
(Cooper)

ENGL 622. SPECIAL STUDIES IN ENGLISH LITERATURE — 17TH CENTURY LITERATURE (3)
(G. Hamilton, Murphy)

ENGL 623. SPECIAL STUDIES IN ENGLISH LITERATURE — 18TH CENTURY LITERATURE (3)
(Kenny, Myers)

ENGL 624. SPECIAL STUDIES IN ENGLISH LITERATURE — ROMANTIC LITERATURE (3)
(Kinnaird, Smith)

ENGL 625. SPECIAL STUDIES IN ENGLISH LITERATURE — VICTORIAN LITERATURE (3)
(Brown, Cate, Peterson)

ENGL 626. SPECIAL STUDIES IN AMERICAN LITERATURE — AMERICAN LITERATURE BEFORE 1865 (3) (Lawson, Vitzthum, Weigant)

ENGL 627. SPECIAL STUDIES IN AMERICAN LITERATURE — AMERICAN LITERATURE SINCE 1865 (3) (Holton, Lawson, Thorberg)

ENGL 718. SEMINAR IN MEDIEVAL LITERATURE (3)
(Birdsall, Isaacs, Rutherford, Schoeck)

ENGL 719. SEMINAR IN RENAISSANCE LITERATURE (3)
(Barry, Cooper, Houppert, McManaway, Schoeck)

ENGL 728. SEMINAR IN SEVENTEENTH-CENTURY LITERATURE (3)
(Freedman, G. Hamilton, Mish, Murphy)

ENGL 729. SEMINAR IN EIGHTEENTH-CENTURY LITERATURE (3) (Kenny, Myers, Ward)

ENGL 738. SEMINAR IN NINETEENTH-CENTURY LITERATURE (3) (Howard, Kinnaird, G. Smith)

ENGL 739. SEMINAR IN NINETEENTH-CENTURY LITERATURE (3) (Brown, Cate, Kleine, Peterson)

ENGL 748. SEMINAR IN AMERICAN LITERATURE (3)
(Barnes, Bode, Holton, Hovey, Lawson, Lutwack, Vitzthum)

ENGL 749. STUDIES IN TWENTIETH-CENTURY LITERATURE (3)
(Bode, Hovey, Lutwack, Panichas, Perloff, Russell)

ENGL 758. LITERARY CRITICISM (3)
(Barry, Lutwack)

ENGL 759. SEMINAR IN LITERATURE AND THE OTHER ARTS (3) (Myers)

ENGL 768. STUDIES IN DRAMA (3)
(Barry, Bryer, Freedman)

ENGL 769. STUDIES IN FICTION (3) (Mish)

ENGL 778. SEMINAR IN FOLKLORE (3) (Fry)

ENGL 788. STUDIES IN THE ENGLISH LANGUAGE (3)
May be repeated for credit to a maximum of 9 hours.

ENGL 799. MASTER'S THESIS RESEARCH (1-6)

ENGL 819. SEMINAR IN THEMES AND TYPES IN ENGLISH LITERATURE (3)

ENGL 828. SEMINAR IN THEMES AND TYPES IN AMERICAN LITERATURE (3)

ENGL 899. DOCTORAL DISSERTATION RESEARCH (1-8)

ENTOMOLOGY PROGRAM

Professor and Chairman: Bay
Professors: Bickley, Harrison, Jones, Menzer, Messersmith, Steinhauer
Associate Professor: Davidson
Assistant Professors: Caron, Reichelderfer
Lecturers: Heimpel, Spangler

The Department of Entomology offers both the M.S. and Ph.D. degrees. Graduate students may specialize in physiology and morphology, toxicology, biosystematics, ecology and behavior, medical entomology, apiculture, insect pathology, and insect pest management.

Students applying for graduate work in entomology are expected to have strong backgrounds in biological sciences, chemistry, and mathematics. Undergraduate preparation in entomology is not required.

The student is given great latitude in selection of advisory study committees, choice of major study areas and supporting course work, and choice of the research problem area. Competence in one foreign language is required for the Ph.D.

Facilities are maintained for research in all areas of specialization offered and, in addition, cooperative programs with other departments in Life Sciences and Agriculture are possible. Specialized facilities are frequently made available to graduate students by many government agencies, such as the National Agricultural Research Center and the U.S. National Museum.

Departmental "Guidelines for Graduate Students" have been prepared and are available from the Department of Entomology, University of Maryland, College Park, Maryland 20742.

ENTM 407. ENTOMOLOGY FOR SCIENCE TEACHERS (4)
Summer. Four lectures and four three-hour laboratory periods a week. This course will include the elements of morphology, taxonomy and biology of insects using examples commonly available to high school teachers. It will include practice in collecting, preserving, rearing and experimenting with insects insofar as time will permit.

ENTM 412. ADVANCED APICULTURE (3)
One lecture and two 3-hour laboratory periods a week. Prerequisite, ENTM 111. The theory and

practice of apiary management. Designed for the student who wishes to keep bees or requires a practical knowledge of bee management.

ENTM 421. INSECT TAXONOMY AND BIOLOGY (4)
Two lectures and two 3-hour laboratory periods a week. Prerequisite, ENTM 200. Introduction to the principles of systematic entomology and the study of all orders and the important families of insects; immature forms considered.

ENTM 432. INSECT MORPHOLOGY (4)
Two lectures and two 3-hour laboratory periods a week. Prerequisite, ENTM 200. A basic study of insect form, structure and organization in relation to function.

ENTM 442. INSECT PHYSIOLOGY (4)
Two lectures and two 3-hour laboratory periods a week. Prerequisites, ENTM 200, CHEM 104 or equivalent. Lectures and laboratory exercises on the cuticle, growth, endocrines, muscles, circulation, nerves, digestion, excretion and reproduction in insects.

ENTM 451. ECONOMIC ENTOMOLOGY (4)
Two lectures and two 2-hour laboratory periods a week. Prerequisite, ENTM 200. The recognition, biology and control of insects injurious to fruit and vegetable crops, field crops and stored products.

ENTM 452. INSECTICIDES (2)
Prerequisite, consent of the department. The development and use of contact and stomach poisons, fumigants and other important chemicals, with reference to their chemistry, toxic action, compatibility, and host injury. Recent research emphasized.

ENTM 462. INSECT PATHOLOGY (3)
Two lectures and one 3-hour laboratory period per week. Prerequisite, MICB 200, prerequisite or corequisite, ENTM 442 or consent of the instructor. An introduction to the principal insect pathogens with special reference to symptomology, epizootiology, and microbial control of insect pests.

ENTM 472. MEDICAL AND VETERINARY ENTOMOLOGY (4)
Three lectures and one 2-hour laboratory period a week. Prerequisite, ENTM 200 or consent of the department. A study of the morphology, taxonomy, biology and control of the arthropod parasites and disease vectors of man and animals. The ecology and behavior of vectors in relation to disease transmission will be emphasized.

ENTM 498. SEMINAR (1)
Prerequisite, senior standing. Presentation of original work, reviews and abstracts of literature.

ENTM 612. INSECT ECOLOGY (2)
One lecture and one 2-hour laboratory period a week. Prerequisite, consent of the department. A study of fundamental factors involved in the relationship of insects to their environment. Emphasis is placed on the insect as a dynamic organism adjusted to its surroundings.

ENTM 625. EXPERIMENTAL HONEY BEE BIOLOGY (2)
One 3-hour lab a week. Fifteen labs during semester will include topics such as communication, nest construction and organization, behavior, insect societies and bee and wasp biology.

ENTM 641. ADVANCES IN INSECT PHYSIOLOGY (2)
Two lectures a week. Prerequisites, ENTM 442 or consent of instructor. Lectures on current literature with reading assignments and discussion.

ENTM 643. ASPECTS OF INSECT BIOCHEMISTRY (2)
Two lectures a week. (Alternate years.) Prerequisite, one year of biochemistry, or equivalent, or consent of the instructor. Lectures and group discussions on the energy sources of insects, intermediary metabolism, utilization of energy sources, specialized subjects of current interest, such as light production, insect pigment formation, pheromones, venoms, and chemical defense mechanisms.

ENTM 653. TOXICOLOGY OF INSECTICIDES (4)
Three lectures and one 3-hour laboratory period a week. (Alternate years, not offered 1973-1974.) Prerequisite, permission of the instructor. A study of the physical, chemical, and biological properties of insecticides. Emphasis is placed on the relationship of chemical structures to insecticidal activity and mode of action. Mechanisms of resistance are also considered.

ENTM 654. INSECT PEST POPULATION MANAGEMENT (2)
2 lecture periods a week. Prerequisite, consent of instructor. A study of current developments in pest management theory and practice, with emphasis on advances in non-pesticide methods of insect control. Frequent guest lecturers will appear. The course will explore insect pest population suppression through the management of ecological factors, such as parasites, predators, microbial agents, resistant hosts, and other agents such as hormones, attractants and repellants, and integrated systems.

ENTM 672. CULICIDOLOGY (2)
One lecture and one 3-hour laboratory period a week. (Alternate years.) The classification, distribution, ecology, biology, and control of mosquitoes.

ENTM 689. ENTOMOLOGICAL TOPICS (1-3)
One lecture or one two-hour laboratory period a week for each credit hour. Prerequisite, consent of department. Lectures, group discussions or laboratory sessions on selected topics such as: aquatic insects, biological control of insects, entomological literature, forest entomology, history of entomology, insect biochemistry, insect embryology, immature insects, insect behavior, principles of economic entomology, insect communication, principles of entomological research.

ENTM 698. SEMINAR (1)
Presentation of topics of current interest, including thesis and dissertation research, by faculty members, students, and outside speakers.

ENTM 699. ADVANCED ENTOMOLOGY (1-6)
Credit and prerequisites to be determined by the department. First and second semesters. Studies of minor problems in morphology, physiology, taxonomy and applied entomology, with particular reference to the preparation of the student for individual research.

ENTM 799. MASTER'S THESIS RESEARCH (1-6)

ENTM 899. DOCTORAL DISSERTATION RESEARCH (1-8)

FIRE PROTECTION ENGINEERING COURSES

ENFP 411. SYSTEMS APPROACH TO FIRE PROTECTION DESIGN (3)
Two lectures and one laboratory period a week. Prerequisite, senior standing. Examination of the problem areas associated with manufacturing, process, laboratory, and transportation systems. Design projects will involve the total application of fire protection engineering, with economic and cost benefit analysis.

ENFP 414. LIFE SAFETY ANALYSIS (3)
Two lectures and one laboratory period a week. Prerequisite, ENFP 321. Detailed examination and study of the physical and psychological variables related to the occurrence of casualties. Investigation of functional features of enclosures relative to egress, and smoke and gas fluid flow. Examination and analysis procedures.

ENFP 415. FIRE PROTECTION FLUIDS II (3)
Two lectures and one laboratory period a week. Prerequisites, ENFP 310, 312. The application of hydraulic and fluid theory to design calculations for aqueous, gaseous and particle fire suppression systems. Problem calculation projects based upon design layouts developed in ENFP 310.

ENFP 416. PROBLEM SYNTHESIS AND DESIGN (3)
Two lectures and one laboratory period a week. Prerequisite, senior standing. Techniques and procedures of problem orientation and solution design utilizing logical and numerical procedures. Student development of research projects in selected areas.

INSTITUTE FOR FLUID DYNAMICS AND APPLIED MATHEMATICS

Research Professor and Director: Crane
Research Professors: Aziz,[1] Babuska, Bhatia,[1] Burgers, DeClaris,[3] Elsasser, Faller, Hubbard, Jones, Karlovitz, Kellogg, Koopman, Landsberg, Lashinsky, Olver, Ortega,[5] Pai, Tidman, Weiss,[3] Wilkerson, Wu, Yorke, Zwanzig
Professors: Brush,[2] Dorfman [4]
Research Associate Professors: Coplan, Guernsey, Israel,[6] Koopman, Matthews, Yorke
Associate Professors: Rodenhuis, Thompson, Vernekar
Visiting Lecturer: Gerrity

[1] joint appointment with UMBC
[2] joint appointment with History
[3] joint appointment with Electrical Engineering
[4] joint appointment with Physics
[5] joint appointment with Computer Science and Mathematics
[6] joint appointment with Civil Engineering

The Institute for Fluid Dynamics and Applied Mathematics is a center for applied interdisciplinary research in areas requiring combined efforts in physical and mathematical sciences, environmental sciences, and engineering. It hosts a faculty of eminent stature to promote a variety of programs, many involving members of other departments on campus and from other institutions. Its purpose is to provide graduate training for students interested in having an opportunity to perform research in a multidisciplinary environment.

The Institute faculty conducts theoretical and experimental research in meteorology, atomic and molecular physics, plasma physics, atmospheric physics, fluid dynamics, statistical mechanics, history of science, theoretical biology and geophysics, and in all areas of applied mathematics. Applied mathematicians in the Institute are currently studying topics in numerical analysis, control theory, nonlinear processes, elasticity, asymptotic expansions, approximation theory, and in application of mathematics to the sciences and environmental sciences. Individual research efforts are coordinated wherever possible to constitute broad programs in the atmospheric, environmental, space and life sciences. Research topics are determined entirely by the interests of students and faculty. Inter-departmental programs are strongly encouraged.

Students interested in pursuing advanced study within the Institute may be admitted to the University as graduate students in any department of engineering, or in mathematics, physics, or chemistry. Those interested in meteorology may be admitted directly to the Graduate Program in Meteorology, which exists within the Institute. (See the separate listing for the Meteorology Program.) Further information may be obtained by writing to the Director of the Institute for Fluid Dynamics and Applied Mathematics.

FOOD, NUTRITION, AND INSTITUTION ADMINISTRATION PROGRAM

Professor and Chairman: Prather
Associate Professors: Ahrens, Butler, Cox
Assistant Professors: Berdanier, Eheart, Sanford (visiting).
Lecturer: Stewart

The department offers a program leading to a Master of Science degree in each of the following major areas: food, nutrition and institution administration. The department participates in an interdepartmental program for Master of Science and Doctor of Philosophy degrees in nutritional science which is described under that title. There is also a coordinated program in cooperation with the U.S. Army Medical Department at Walter Reed General Hospital, Washington, D.C., for Dietetic Interns, leading to a Master of Science degree.

A satisfactory score on the aptitude portion of the Graduate Record Examination is required for admission.

Thesis and non-thesis options are available for the Master of Science degree in food, nutrition or institution administration, but the Master of Science degree in nutritional science is available only through a thesis option.

A limited number of graduate assistantships are available.

Copies of department requirements are available from the department for the information and guidance of graduate students.

FOOD

FOOD 440. ADVANCED FOOD SCIENCE (3)
Three lectures per week. Prerequisites, FOOD 240, 250, CHEM 461 or concurrent registration. Chemist and physical properties of food as related to consumer use in the home and institutions.

FOOD 450. EXPERIMENTAL FOOD SCIENCE (3)
One lecture, two laboratories per week. Prerequisite, FOOD 440 or equivalent. Individual and group laboratory experimentation as an introduction to methods of food research.

FOOD 455. ADVANCED FOOD SCIENCE LABORATORY (1)
One 3-hour laboratory per week. Prerequisite, CHEM 201 and consent of instructor. Chemical determination of selected components in animal and plant foods.

FOOD 480. FOOD ADDITIVES (3)
Prerequisite, FOOD 440 or equivalent. Efforts of intentional and incidental additives on food quality, nutritive value and safety. FDA approved additives, GRAS substances, pesticide residues, mycotoxins, antibiotics, and hormones will be reviewed.

FOOD 490. SPECIAL PROBLEMS IN FOODS (2-3)
Prerequisite, FOOD 440 and consent of instructor. Individual selected problems in the area of food science.

FOOD 610. READINGS IN FOOD (3)
Prerequisite, FOOD 440 or consent of instructor. A critical survey of the literature of recent developments in food research.

FOOD 620. NUTRITIONAL AND QUALITY EVALUATION OF FOOD (3)
Prerequisite, FOOD 440 or consent of instructor. Effects of production, processing, marketing, storage, and preparation on nutritive value and quality of foods.

FOOD 640. FOOD ENZYMES (3)
Two lectures and one 3-hour laboratory. Prerequisite, FOOD 440 or equivalent. The classification and behavior of naturally occurring and added enzymes in food; includes the effects of temperature, pH, radiation, moisture, etc., on enzyme activity.

FOOD 650. ADVANCED EXPERIMENTAL FOOD (3-5)
Two lectures and three laboratory periods a week. Selected readings of literature in experimental foods. Development of individual problem.

FOOD 678. SPECIAL TOPICS IN FOODS (1-6)
Individual or group study in an area of foods.

FOOD 688. SEMINAR (1-2)
Reports and discussions of current research in foods.

FOOD 799. MASTER'S THESIS RESEARCH (1-6)

NUTRITION

NUTR 415.—MATERNAL, INFANT AND CHILD NUTRITION (2)
Two lectures per week. Prerequisites, course in basic nutrition. Nutritional needs of the mother, infant and child and the relation of nutrition to physical and mental growth.

NUTR 425. INTERNATIONAL NUTRITION (2)
Two lectures per week. Prerequisite, course in basic nutrition. Nutritional status of world population and local, national and international programs for improvement.

NUTR 435. HISTORY OF NUTRITION (2)
Two lectures per week. Prerequisite, course in basic nutrition. A study of the development of the knowledge of nutrition and its interrelationship with social and economic developments.

NUTR 450. ADVANCED HUMAN NUTRITION (3)
Prerequisites, consent of department; NUSC 402 or NUTR 300; CHEM 461, or concurrent registration. Two lectures and one 2-hour laboratory. A critical study of the physiological and metabolic influences on nutrient utilization, with particular emphasis on current problems in human nutrition.

NUTR 460. THERAPEUTIC HUMAN NUTRITION (3)
Two lectures and one laboratory period a week. Prerequisites, NUTR 300, 450. Modifications of the normal adequate diet to meet human nutritional needs in pathological conditions.

NUTR 470. COMMUNITY NUTRITION (3)
Prerequisites, NUTR 300, 450, 460. A study of different types of community nutrition programs, problems and projects.

NUTR 480. APPLIED DIET THERAPY (3)
(Open only to students accepted into and participating in the United States Army Dietetic Internship Program at Walter Reed General Hospital or the Coordinated Undergraduate Dietetics Program.) Application of principles of normal and therapeutic nutrition in total medical care and instruction of patients. Clinical experience in hospital therapeutics, pediatrics, research and a variety of clinics are included.

NUTR 490. SPECIAL PROBLEMS IN NUTRITION (2-3)
Prerequisites, NUTR 300 and consent of instructor. Individual selected problems in the area of human nutrition.

NUTR 600. RECENT PROGRESS IN HUMAN NUTRITION (3)
Recent developments in the science of nutrition with emphasis on the interpretation of these findings for application in health and disease.

NUTR 610. READINGS IN NUTRITION (1-3)
Reports and discussions of significant nutritional research and investigation.

NUTR 620. NUTRITION FOR COMMUNITY SERVICES (3)
Application of the principles of nutrition to various community problems of specific groups of the public. Students may select specific problems for independent study.

NUTR 670. INTERMEDIARY METABOLISM IN NUTRITION (3)
Prerequisite, CHEM 461, 462 or equivalent. The major routes of carbohydrate, fat, and protein metabolism with particular emphasis on metabolic shifts and their detection and signifiance in nutrition.

NUTR 678. SPECIAL TOPICS IN NUTRITION (1-6)
Individual or group study in an area of nutrition.

NUTR 680. HUMAN NUTRITION STATUS (3)
Methods of appraisal of human nutritional status, to include dietary, biochemical and anthropometric techniques.

NUTR 698. SEMINAR IN NUTRITION (1-3)
A study in depth of a selected phase of nutrition.

NUTR 699. PROBLEMS IN NUTRITION (1-4)
Prerequisite, permission of faculty. Experience in a phase of nutrition of interest to the student. Use is made of experimental animals, human studies and extensive, critical studies of research methods, techniques or data of specific projects.

NUTR 799. MASTER'S THESIS RESEARCH (1-6)

INSTITUTION ADMINISTRATION

IADM 410. SCHOOL FOOD SERVICE (3)
Two lectures and one morning a week for field experience in a school food service. Prerequisite, FOOD 200, or 240 and 250, and NUTR 300, or consent of instructor. Study of organization and management, menu planning, food purchasing, preparation, service, and cost control in a school lunch program.

IADM 420. QUANTITY FOOD PURCHASING (3)
Prerequisite, FOOD 240, introductory accounting recommended. Food selection and the development of integrated purchasing programs. Standards of quality; the marketing distribution system.

IADM 430. QUANTITY FOOD PRODUCTION (3)
Two hours of lecture and one 3-hour laboratory a week. Prerequisites, FOOD 240, or consent of instructor. Scientific principles and procedures employed in food preparation in large quantity. Laboratory experience in management techniques in quantity food production and service.

IADM 440. FOOD SERVICE PERSONNEL ADMINISTRATION (2)
Prerequisite, IADM 300. Principles of personnel administration in food services, emphasis on personnel selection, supervision and training, job evaluation, wage and payroll structure, current labor regulation, and interpersonal relationships and communications.

IADM 450. FOOD SERVICE EQUIPMENT AND PLANNING (2)
Two lectures a week. Prerequisite, consent of instructor. Equipment design, selection, maintenance and efficient layout, relation of the physical facility to production and service.

IADM 460. ADMINISTRATION DIETETICS (3)
(Open only to students accepted into and participating in the United States Army Dietetic internship Program at Walter Reed General Hospital or the Coordinated Undergraduate Dietetic Program.) Application of management theory through guided experience in all aspects of hospital dietary department administration.

IADM 470. ADMINISTRATIVE DIETETICS II (3)
Continuation of IADM 460.

IADM 490. SPECIAL PROBLEMS IN FOOD SERVICE (2-3)
Prerequisites, senior standing, five hours in IADM courses and consent of instructor. Individual selected problems in the area of food service.

IADM 600. FOOD SERVICE ADMINISTRATION (3)
Principles of organization and management related to a food system. Control of resources through the use of quantitative methods. Administrative decision-making, and personnel policies and practices.

IADM 610. READINGS IN FOOD ADMINISTRATION (3)
Reports and discussion of significant research and development in the area of food admniistration.

IADM 630. COMPUTER APPLICATION IN FOOD SERVICE (3)
Prerequisite, IADM 600 or equivalent. The use of automatic data processing and programming for the procurement and issuing of food commodities, processing of ingredients, menu selection, and labor allocations.

IADM 640. SANITATION AND SAFETY IN FOOD SERVICE (3)
Prerequisite, MICB 200. Principles and practices of sanitation and safety unique to the production, storage and service of food in quantity; includes current legislation.

IADM 650. EXPERIMENTAL QUANTITY FOOD PRODUCTION (3)
Two lectures and one 3-hour laboratory. Prerequisites, IADM 430 and FOOD 450 or equivalents. Application of experimental methods to quantity food production, recipe development and modification; relationship of food quality to production methods.

IADM 678. SPECIAL TOPICS IN INSTITUTIONAL FOOD (1-6)
Individual or group study in an area of institutional food service.

IADM 688. SEMINAR (1)
Reports and discussion of current research in institution administration. May be repeated to a maximum of three semestter hours of credit.

IADM 799. MASTER'S THESIS RESEARCH (1-6)

FOOD SCIENCE PROGRAM

Professor and Chairman: King (Dairy Science)
Professors: Kramer, Scott, Stark (Horticulture). Twigg. and Wiley (Horticulture). Davis, and Mattick (Dairy Science). Young (Animal Science).
Associate Professors: Bigbee and Thomas (Poultry Science)
Assistant Professor: Heath

The Master of Science and Doctor of Philosophy degrees are offered in the Food Science Program. This graduate program is interdepartmental, offered under the aegis of the Departments of Horticulture, Dairy Science, Poultry Science and Animal Science. Areas of specialization include: quality control, product and process development, management and marketing, waste control, and byproduct utilization. The student may pursue work in the chemical, physical, bacteriological and nutritional aspects of food products.

Students seeking admission should present adequate undergraduate preparation in the biological and physical sciences. Deficiences at the lower level in these areas should be corrected by enrollment as a special undergraduate student. Students are admitted for the doctorate if it is clear they can complete the program successfully. The Graduate Record Examination is not required.

A non-thesis Master's option is available to candidates for whom the M.S. degree will be terminal.

FDSC 412. PRINCIPLES OF FOOD PROCESSING I (3)
Two lectures and one laboratory per week. A study of the basic methods by which foods are preserved (unit operations). Effect of raw product quality and the various types of processes on yield and quality of the preserved products. (Wiley)

FDSC 413. PRINCIPLES OF FOOD PROCESSING II (3)
Three lectures per week. A detailed study of food processing with emphasis on line and staff operations, including physical facilities, utilities, pre-and post-processing operations, processing line development and sanitation. (Mattick)

FDSC 421. FOOD CHEMISTRY (3)
Two lectures and one laboratory per week. Prerequisites, CHEM 201 and 202. The application of basic chemical and physical concepts to the composition and properties of foods. Emphasis will be on the relationship of processing technology to the keeping quality, nutritional value and acceptability of foods. (King)

FDSC 422. FOOD PRODUCT RESEARCH AND DEVELOPMENT (3)
Two lectures, and one laboratory per week. Prerequisite, FDSC. 413, CHEM 461, or permission of instructor. A study of the research and development function for improvement of existing products and development of new, economically feasible and marketable food products. Application of chemical-physical characteristics of ingredients to produce optimum quality products, cost reduction, consumer evaluation, equipment and package development. (Mattick)

FDSC 430. FOOD MICROBIOLOGY (4)
Two lectures and one formal laboratory per week. Prerequisite, MICB 200. Additional independent laboratory work required. Time would be equivalent to a second laboratory period per week. Microorganisms of major importance to the food industry are studied with emphasis on their isolation, identification, bio-processing of foods, and public health significance. (Westhoff)

FDSC 431. FOOD QUALITY CONTROL (2)
Two lectures per week. Definition and organization of the quality control function in the food industry. Preparation of specifications. Statistical methods for acceptance sampling, in-plant and processed product inspection. Instrumental and sensory methods for evaluating sensory quality, identity and wholesomeness and their integration into grades and standards of quality. (Kramer)

FDSC 432. FOOD QUALITY CONTROL LABORATORY (2)
Two laboratories per week. Chemical-physical, instrumental, microanalytical, sensory analysis of food quality attributes. Using data obtained, calculate sampling plans, control charts, process capabilities, grades and standards. Prerequisite or concurrent registration in FDSC 431. (Kramer)

FDSC 442. HORTICULTURAL PRODUCTS PROCESSING (3)
Two lectures and one laboratory per week. Commercial methods of canning, freezing, dehydrating, fermenting, and chemical preservation of fruit and vegetable crops. (Wiley)

FDSC 451. DAIRY PRODUCTS PROCESSING (3)
Two lectures and one laboratory per week. Method of production of fluid milk, butter, cheese, condensed and evaporated milk and milk products and ice cream.

FDSC 461. TECHNOLOGY OF MARKET EGGS AND POULTRY (3)
Two lectures and one laboratory per week. A study of the technological factors concerned with the processing, storage, and marketing of eggs and poultry and the factors affecting their quality (Heath)

FDSC 471. MEAT AND MEAT PROCESSING (3)
Two lectures and one laboratory per week. Prerequisite, CHEM 461 or permission of instructor. Physical and chemical characteristics of meat and meat products, meat processing, methods of testing and product development. (Sulzbacher)

FDSC 482. SEAFOOD PRODUCTS PROCESSING (3)
Two lectures and one laboratory a week. Prerequisite, CHEM 461 or permission of instructor. The principal preservation methods for commercial seafood products with particular reference to the invertebrates. Chemical and microbiological aspects of processing are emphasized.

FDSC 621. SYSTEMS ANALYSIS IN THE FOOD INDUSTRY (3)
Construction and solution of models for optimizing feed, product formulations, nutrient-palatability costs. Methods for optimizing processes, inventories, and transportation systems.

FDSC 631. ADVANCED FOOD MICROBIOLOGY (2)
One lecture and one laboratory period a week. Prerequisite: FDSC 430 or permission of instructor. An in-depth understanding and working knowledge of a selected number of problem areas and contemporary topics in Food Microbiology.

FDSC 689. SEMINAR IN FOOD SCIENCE (1-3)
A. Lipids. B. Proteins. C. Carbohydrates. D. Organoleptic Properties. E. Fermentation. F. Enzymes and Microorganisms. G. Flavor Analysis. I. Assays. Studies in depth of selected phases of food science are frequently best arranged by employment of a lecturer from outside the University to teach a specific phase. Flexibility in the credit offered permits adjustment to the nature of the course.

FDSC 698. COLLOQUIUM IN FOOD SCIENCE (1)
Oral reports on special topics or recently published research in food science and technology. Distinguished scientists are invited as guest lecturers. A maximum of three credits allowed for the M.S.

FDSC 699. SPECIAL PROBLEMS IN FOOD SCIENCE (1-4)
Prerequisite, CHEM 461 or permission of instructor. Credit according to time scheduled and magnitude of problem. An experimental program on a topic other than the student's thesis problem will be conducted. Four credits shall be the maximum allowed toward an advanced degree.

FDSC 799. MASTER'S THESIS RESEARCH (1-6)

FDSC 811. ADVANCES IN FOOD TECHNOLOGY (3)
Prerequisite, CHEM 461 or permission of instructor. A systematic review of new products, processes and management practices in the food industry. (Kramer)

FDSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

FOUNDATIONS OF EDUCATION PROGRAM

Professor and Chairman: Male
Associate Professors: Agre, Huden, Lindsay· Noll
Assistant Professors: Finkelstein, Hopkins

The objectives of the program in Foundations of Education are to prepare specialists in the disciplines of history of education, philosophy of education, educational sociology and comparative education and some generalists with a broad command of two or more of these fields. The specialists and generalists are prepared for undergraduate and graduate college or university teaching, for research, and for policy positions. Foundations courses are also used to enrich programs in other areas and to provide needed disciplinary capacity for students whose research and career goals require it.

Graduate Foundations majors, and particularly those at the doctoral level, are expected to have knowledge of the history, sociology, and philosophy of education, as well as comparative education. Each in turn specializes in one of these areas with related work in history, philosophy, government and politics, anthropology, and/or sociology.

In addition to the overall "B" average a Master of Arts applicant must have a "B" average in the last two years of the undergraduate program from a regionally accredited institution. An applicant for the Doctor of Philosophy degree must have strong undergraduate and graduate records, and a Miller Analogies Test score at the midpoint or better of the graduate Education population at the University of Maryland.

The requirements for the M.A. with and without thesis, and for the Ph.D. conform to those of The Graduate School. Beyond the stipulation that each student shall be both a generalist and a specialist, there are no special requirements for all students. Instead, programs are tailored to a student's objectives.

The Washington area and the University are rich in resources for graduate study and research. The College Park campus is adjacent to embassies which provide access to materials for the study of foreign education systems. Staff members in Foundations are assigned to a Comparative Education Center which provides research facilities to students from both foreign and American backgrounds.

EDSF 409. SPECIAL TOPICS IN THE FOUNDATIONS OF EDUCATION (1-3)
An intensive examination of current problems and issues in the formation of educational policies. May be repeated for credit when the topics dealt with are different. Repeatable to a maximum of 9 hours.

EDSF 410. HISTORY OF EDUCATION IN WESTERN CIVILIZATION (3)
Educational institutions through the ancient, medieval and early modern periods in Western Civilization, as seen against a background of socio-economic development.

EDSF 411 HISTORY OF EDUCATION IN THE UNITED STATES (3)
A study of the origins and development of the chief features of the present system of education in the United States.

EDSF 420. PHILOSOPHY OF EDUCATION (3)
A study of the great educational philosophers and systems of thought affecting the development of modern education.

EDSF 421. LOGIC OF TEACHING (3)
An analysis of the structure of basic subject matters in the curriculum and of the standard logical moves in teaching.

EDSF 430. EDUCATIONAL SOCIOLOGY (3)
Deals with data of the social sciences which are germane to the work of teachers. Implications of democratic ideology for educational endeavor, educational tasks imposed by changes in population and technological trends, the welfare status of pupils, the socio-economic attitudes of individuals who control the schools, and other elements of community background.

EDSF 489. FIELD EXPERIENCE IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in

which the experience is to be taken. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field experience has been approved by the education faculty. Field experience is offered in a given area to both major and nonmajor students.

Note: the total number of credits which a student may earn in 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDSF 498. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDSF 499. WORKSHOPS, CLINICS, AND INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the College of Education (or developed cooperatively with other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDSF 660. COMPARATIVE EDUCATION (3)
Analyzes and compares leading issues in education in various countries of the world, particularly as they relate to crucial problems in American education.

EDSF 661. INTERNATIONAL ORGANIZATION AND EDUCATIONAL CHANGE (3)

EDSF 670. EDUCATION IN AFRICA (3)
An examination of the development of modern educational systems in Africa south of the Sahara out of the Colonial and Pre-Colonial past into the independent present and future. The focus is on research into the changing philosophies and persistent problems in African education.

EDSF 671. EDUCATION IN THE NEAR EAST (3)
A consideration of current educational problems of the Near East as they have emerged from the confrontation of the traditional Muslim educational heritage with the foreign educational activities and the forces of nationalism and modernization.

EDSF 709. SEMINAR IN HISTORY AND PHILOSOPHY OF EDUCATION (3)

EDSF 730. SEMINAR IN EDUCATIONAL SOCIOLOGY (3)

EDSF 760. SEMINAR IN COMPARATIVE EDUCATION (3)

EDSF 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisers may register for credit under this number.

EDSF 799. MASTER'S THESIS RESEARCH (1-6)
Six hours required for master's thesis.

EDSF 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's degree in Education, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDUL 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSF 889. INTERNSHIP IN EDUCATION (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the doctor's degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *NOTE:* The total number of credits which a student may earn in EDUL 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSF 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an Ed.D. project and 12-18 hours required for a Ph.D. dissertation.

FRENCH LANGUAGE AND LITERATURE PROGRAM

Professor and Chairman: MacBain
Professors: Bingham, Rosenfield
Associate Professors: Demaitre, Fink, Tarica
Assistant Professors: Gilbert, Hicks, Lebreton-Savigny, McArthur, Meijer, Salchenberger

The department prepares students for the M.A. and Ph.D. degrees in French language and literature. Students are encouraged to work in the closest contact with faculty advisors of their choice, in order that their programs be the most appropriate and most rewarding for their individual needs and interests.

The composition of the faculty and the variety of course offerings make it possible for students to specialize in any period or movement of French literature, or any aspect of the French language with the consent of their advisers.

Entry into the M.A. program is open to students having a solid grounding in French language and literature. All applicants, whether graduates of the University of Maryland or not, must take all parts of the G.R.E., including the Advanced Examination in French.

Successful completion of the M.A. program, with or without thesis, involves passing a Comprehensive Examination in three parts: the Graduate Language Proficiency Examination (translation into and from French); a six-hour examination in French literature from the Middle Ages to the present (a reading knowledge of Old French will be supposed); and a one hour oral examination in French literature from the Middle Ages to the present.

Entry into the Ph.D. program is open to only the most highly qualified and most highly motivated candidates who can show that individual research is their major interest, and who give evidence of strong qualifications to pursue that interest.

All applicants for the Ph.D program (except M.A. graduates of this department) must pass a three-part Preliminary Examination, consisting of an *explication de texte,* an essay and an oral examination before being fully admitted to the program at the end of their first year. (The Preliminary Examination is administered at the start of the Fall Semester.) They will then be required to pass five Special Topic examinations within a two-year period.

Complete information concerning the department's requirements are set forth in *Guide to Graduate Programs in French,* available by writing to the Department of French Language and Literature, University of Maryland, College Park, Maryland 20742.

FRENCH

FREN 400. APPLIED LINGUISTICS (3)
The nature of applied linguistics and its contribution to the effective teaching of foreign languages. Comparative study of English and French, with emphasis upon points of divergence. Analysis, evaluation and construction of related drills. (McArthur)

FREN 401. INTRODUCTION TO STYLISTICS (3)
Prerequisite, FREN 302, or course chairman's consent. Comparative stylistic analysis; detailed grammatical analysis; translation. (Lloyd-Jones)

FREN 405. EXPLICATION DE TEXTES (3)
Oral and written analysis of short literary works, or of excerpts from longer works chosen for their historical, structural, or stylistic interest, with the purpose of training the major to understand literature in depth and to make mature esthetic evaluations of it. (Fink)

FREN 411, 412. INTRODUCTION TO MEDIEVAL LITERATURE (3, 3)
French literature from the Ninth through the Fifteenth Century. *La Chanson Epique, Le Roman Courtois, Le Lai; La Littérature Bourgeoise, Le Théâtre, La Poésie Lyrique.* (Hicks, Lloyd-Jones)

FREN 421, 422. FRENCH LITERATURE OF THE SIXTEENTH CENTURY (3, 3)
The Renaissance in France: Humanism, Rabelais, Calvin, the Pléiade, Montaigne, Baroque Poetry. (Lloyd-Jones, Meijer)

FREN 431, 432. FRENCH LITERATURE OF THE SEVENTEENTH CENTURY (3, 3)
Descartes, Pascal, Corneille, Racine; the remaining great classical writers, with special attention to Molière. (MacBain, Rosenfield)

FREN 441, 442. FRENCH LITERATURE OF THE EIGHTEENTH CENTURY (3, 3)
Development of philosophical and scientific movement; Montesquieu, Voltaire, Diderot, Rousseau. (Bingham, Fink)

FREN 451, 452. FRENCH LITERATURE OF THE NINETEENTH CENTURY (3, 3)
Drama and poetry from Romanticism to Symbolism; the major prose writers of the same period. (Gilbert, Lebreton-Savigny)

FREN 461. STUDIES IN TWENIETH CENTURY LITERATURE — THE EARLY YEARS (3)
French poetry, theater and the novel during the age of Proust and Gide. (Demaitre, Tarica)

FREN 462. STUDIES IN TWENTIETH CENTURY LITERATURE — MID-CENTURY WRITERS (3)
Modern French poetry, theater and the novel, with special emphasis on the literature of anxiety and Existentialism. (Demaitre, Tarica)

FREN 463. STUDIES IN TWENTIETH CENTURY LITERATURE — THE CONTEMPORARY SCENE (3)
French writers and literary movements since about 1950, with special emphasis on new forms of the novel and theater. (Demaitre, Tarica)

FREN 478. THEMES AND MOVEMENTS OF FRENCH LITERATURE IN TRANSLATION (3)
Studies treatments of thematic problems or of literary or historical movements in French literature. Topic to be determined each semester. Given in English.

FREN 479. MASTERWORKS OF FRENCH LITERATURE IN TRANSLATION (3)
Treats the works of one or more major French writers. Topic to be determined each semester. Given in English.

FREN 488. PRO-SEMINAR IN A GREAT LITERARY FIGURE (3)
Each semester a specialized study will be made of one great French writer chosen from some representative literary period or movement since the Middle Ages. Repeatable for a maximum of six credits.

FREN 489. PRO-SEMINAR IN THEMES OR MOVEMENTS OF FRENCH LITERATURE (3)
Repeatable for a maximum of six credits.

FREN 498. SPECIAL TOPICS IN FRENCH LITERATURE (3)
Repeatable for a maximum of six credits.

FREN 499. SPECIAL TOPICS IN FRENCH STUDIES (3)
An aspect of French studies, the specific topic to be announced each time the course is offered. Repeatable for a maximum of 6 credits.

FREN 600. PROBLEMS IN BIBLIOGRAPHY AND RESEARCH METHODS (3) (Bingham)

FREN 601. THE HISTORY OF THE FRENCH LANGUAGE (3) (MacBain)

FREN 602. COMPARATIVE ROMANCE LINGUISTICS (3)
Also listed as SPAN 612. (Mendeloff)

FREN 603. STYLISTICS (3)
Advanced composition, translation, stylistic analysis. (Tarica)

FREN 609. SPECIAL TOPIC IN THE FRENCH LANGUAGE (3)

FREN 610. LA CHANSON DE ROLAND (3)
Close reading of the text, study of epic formulae and early medieval literary techniques; reading knowledge of old French desirable. (MacBain)

FREN 619. SPECIAL TOPIC IN MEDIEVAL FRENCH LITERATURE (3)

FREN 629. SPECIAL TOPIC IN SIXTEENTH CENTURY FRENCH LITERATURE (3)

FREN 630. CORNEILLE (3) (MacBain)

FREN 631. MOLIERE (3) (MacBain, Rosenfield)

FREN 632. RACINE (3) (MacBain)

FREN 639. SPECIAL TOPIC IN SEVENTEENTH CENTURY FRENCH LITERATURE (3)

FREN 640. VOLTAIRE (3) (Bingham)

FREN 641. ROUSSEAU (3) (Fink)

FREN 642. DIDEROT (3) (Bingham)

FREN 649. SPECIAL TOPIC IN EIGHTEENTH CENTURY FRENCH LITERATURE (3)

FREN 650. FRENCH POETRY IN THE NINETEENTH CENTURY (3)

FREN 651. FRENCH POETRY IN THE NINETEENTH CENTURY (3)

FREN 652. THE FRENCH NOVEL IN THE NINETEENTH CENTURY (3) (Demaitre)

FREN 653. THE FRENCH NOVEL IN THE NINETEENTH CENTURY (3) (Demaitre)

FREN 659. SPECIAL TOPIC IN NINETEENTH CENTURY FRENCH LITERATURE (3)

FREN 660. FRENCH POETRY IN THE TWENTIETH CENTURY (3) (Tarica)

FREN 662. THE FRENCH NOVEL IN THE TWENTIETH CENTURY (Demaitre, Tarica)

FREN 663. THE FRENCH NOVEL IN THE TWENTIETH CENTURY (3) (Demaitre, Tarica)

FREN 664. THE FRENCH THEATRE IN THE TWENTIETH CENTURY (3) (Demaitre)

FREN 665. THE FRENCH THEATRE IN THE TWENTIETH CENTURY (3) (Demaitre)

FREN 669. SPECIAL TOPIC IN TWENTIETH CENTURY FRENCH LITERATURE (3)

FREN 679. THE HISTORY OF IDEAS IN FRANCE (3)
Analysis of currents of ideas as reflected in different periods and authors of French literature.

FREN 689. SEMINAR IN A GREAT LITERARY FIGURE (3)

FREN 699. SEMINAR (3)
Topic to be determined each semester.

FREN 701. COLLEGE TEACHING OF FRENCH (3)
Instruction, demonstration and classroom practice under supervision of modern procedures in the presentation of elementary French courses to college age students. (McArthur)

FREN 702. STRUCTURAL FRENCH LINGUISTICS (3)
Synchronic description of the phonology, morphology and syntax of modern spoken French: standard French in contrast with other varieties. (McArthur)

FREN 799. MASTER'S THESIS RESEARCH (1-6)

FREN 801, 802. INDEPENDENT STUDY (3, 3)
Designed to permit doctoral candidates to work independently in areas of special interest to them, under the close supervision of a professor of their choice.

FREN 818. FRENCH LITERARY CRITICISM (3)
Analysis and evaluation of various trends in literary criticism as a manifestation of the French literary genius. Topic to be determined each semester.

FREN 899. DOCTORAL DISSERTATION RESEARCH (1-6)

ITALIAN

ITAL 410. THE ITALIAN RENAISSANCE (3)
A study of major trends of thought in Renaissance literature, philosophy, art, and science. (Salchenberger)

ITAL 498. SPECIAL TOPICS IN ITALIAN LITERATURE (3)
Repeatable for a maximum of six credits.

ITAL 499. SPECIAL TOPICS IN ITALIAN STUDIES (3)
An aspect of Italian studies, the specific topic to be announced each time the course is offered. Repeatable for a maximum of 6 credits.

GEOGRAPHY PROGRAM

Professor and Chairman: Harper
Professors: Ahnert, Deshler, Fonaroff, Hu
Associate Professors: Brodsky, Chaves, Mitchell, Thompson, Wiedel
Assistant Professors: Cirrincione,[1] Dando, Groves, Lewis, Muller

[1] joint appointment with Secondary Education

The programs for both Master of Arts and Doctor of Philosophy degrees in the Department of Geography

are designed to provide the student with well-rounded competence in the field as well as opportunity for specialization.

The department offers three major areas of specialization in accordance with staff interests and the unique opportunities afforded by the College Park location: Physical Geography, with emphasis on physical systems involving the inter-relationship between geomorphology, climatology, and other environmental elements; Cultural Geography, primarily concerned with the impact of culture (largely the technological and social aspects) on human spatial resource relationships both past and present, with emphasis on tropical settlement, historical geography, health and disease, and resource use; Metropolitan Areas (their function, their interrelations, and their ties to surrounding regions) and supported by affiliation with the University's Institute for Urban Studies, and by the Washington Center for Metropolitan Studies with which the University is associated.

Incoming M.A. students are expected to have an undergraduate degree in the field or in a closely related field, with substantial work in geography. In the latter case, remedial work may be required prior to admission to the degree program.

Because of the degree of specialization inherent in Ph.D. training, the department only considers applicants whose interests coincide with departmental staff competence—in general, the three major areas of geography described above. Prospective students who are unsure whether their interests match those of the department are encouraged to submit a proposal for consideration.

For admission to the doctoral program, the department normally requires a grade-point average higher than 3.0 and an M.A. degree from a recognized geography department, or competence in terms of fields of study and level of achievement comparable to the M.A. degree of the department.

A non M.A.-direct Ph.D. program is possible by petition from the student and upon approval of a faculty committee appointed by the department chairman.

M.A. students have the choice of either thesis or non-thesis programs. The non-thesis option involves the preparation of two substantial research papers. All M.A. students take an oral examination prior to work on the thesis or papers and in a final oral examination based either on the thesis or one of the two research papers.

After completion of formal coursework requirements for the Ph.D., there is a two-part qualifying examination. Part One is a written examination in the student's two major fields of specialization. Part Two is an oral examination evaluating the dissertation proposal. Upon satisfactory completion of the dissertation there is a final oral examination.

Departmental research facilities include a reference library with extensive journal collection, a map collection and a cartographic laboratory. A remote computer console in the building has direct connection with the University's Computer Science Center. There is close liaison with the Departments of Economics, Business Administration, Government and Politics, and with the Bureaus of Business and Economic Research, and of Government Research. The National Library of Agriculture is within two miles of the College Park campus.

More detailed information on the M.A. and Ph.D programs can be obtained from the department.

GEOG 400. GEOGRAPHY OF NORTH AMERICA (3)
An examination of the contemporary patterns of American and Canadian life from a regional viewpoint. Major topics include: the significance of the physical environment, resource use, the political framework, economic activities, demographic and socio-cultural characteristics, regional identification, and regional problems.

GEOG 402. GEOGRAPHY OF MARYLAND AND ADJACENT AREAS (3)
An analysis of the physical environment, natural resources, and population in relation to agriculture, industry, transport, and trade in the state of Maryland and adjacent areas.

GEOG 406. HISTORICAL GEOGRAPHY OF NORTH AMERICA BEFORE 1800 (3)
An analysis of the changing geography of the United States and Canada from Pre-Columbian times to the end of the 18th Century. Emphasis on areal variations and changes in the settlements and economies of Indian and Colonial populations. Areal specialization and the changing patterns of agriculture, industry, trade, and transportation. Population growth, composition and interior expansion. Regionalization.

GEOG 407. HISTORICAL GEOGRAPHY OF NORTH AMERICA AFTER 1800 (3)
An analysis of the changing geography of the United States and Canada from 1800 to the 1920's. Emphasis on the settlement, expansion and socio-economic development of the United States, and comparisons with Canadian experience. Immigration, economic activities, industrialization, transportation and urbanization.

GEOG 410. GEOGRAPHY OF EUROPE (3)
Agricultural and industrial development of Europe and present-day problems in relation to the physical and cultural setting of the continent and its natural resources.

GEOG 411. HISTORICAL GEOGRAPHY OF EUROPE (3)
An analysis of the changing geography of Europe at selected periods from prehistoric times until the end of the 19th Century, with particular emphasis on Western Europe. Changing patterns of population, agriculture, industry, trade and transportation. Development of the nation-state. Impact of overseas expansion. Agricultural and industrial revolutions.

GEOG 415. ECONOMIC RESOURCES AND DEVELOPMENT OF AFRICA (3)
The natural resources of Africa in relation to agricultural and mineral production; the various stages of economic development and the potentialities of the future.

GEOG 420. GEOGRAPHY OF ASIA (3)
Lands, climates, natural resources, and major eco-

nomic activities in Asia (except Soviet Asia). Outstanding differences between major regions.

GEOG 421. ECONOMIC AND POLITICAL GEOGRAPHY OF EASTERN ASIA (3)
Study of China, Korea, Japan, the Philippines; physical geographic setting, population, economic and political geography. Potentialities of major regions and recent developments.

GEOG 422. CULTURAL GEOGRAPHY OF CHINA AND JAPAN (3)
Survey of geographical distribution and interpretation of cultural patterns of China and Japan. Emphasis on basic cultural institutions, outlook on life, unique characteristics of various groups, trends of cultural change and contemporary problems.

GEOG 423. ECONOMIC AND POLITICAL GEOGRAPHY OF SOUTH AND SOUTHEAST ASIA (3)
Study of the Indian subcontinent. Farther India, Indonesia; physical geographic setting, population, economic and political geography, potentialities of various countries and regions and their role in present Asia.

GEOG 431. ECONOMIC AND CULTURAL GEOGRAPHY OF CARIBBEAN AMERICA (3)
An analysis of the physical framework, broad economic and historical trends, cultural patterns, and regional diversification of Mexico, Central America, the West Indies.

GEOG 432. ECONOMIC AND CULTURAL GEOGRAPHY OF SOUTH AMERICA (3)
A survey of natural environment and resources, economic deevlopment and cultural diversity of the South American republics, with emphasis upon problems and prospects of the countries.

GEOG 434. HISTORICAL GEOGRAPHY OF THE HISPANIC WORLD (3)
An examination of the social, economic, political and cultural geography of the countries of the Iberian Peninsula and Latin America in the past with concentration on specific time periods of special significance in the development of these countries.

GEOG 435. GEOGRAPHY OF THE SOVIET UNION (3)
The natural environment and its regional diversity. Geographical factors in the expansion of the Russian state. The geography of agricultural and industrial production in relation to available resources, transportation, problems, and diversity of population.

GEOG 439. INTRODUCTION TO REGIONAL METHODS (3)
Inquiry into the evolution of regional methodology with specific reference to geographic problems. Critical analysis and evaluation of past and contemporary theories and a thorough examination of alternate regional methodologies. Application of quantitative and qualitative techniques of regional analysis and synthesis to traditional and modern regional geography emphasizing principles of regionalization.

GEOG 440. GEOMORPHOLOGY (3)
Study of major morphological processes, the development of land forms and the relationships between various types of land forms and land use problems. Examination of the physical features of the earth's surface and their geographic distributions.

GEOG 441. REGIONAL GEOMORPHOLOGY (3)
Regional and comparative morphology with special emphasis upon Anglo-America.

GEOG 445. CLIMATOLOGY (3)
The geographic aspects of climate with emphasis on energy-moisture budgets, steady-state and non-steady-state climatology, and climatic variations at both macro-and micro-scales.

GEOG 446. SYSTEMATIC AND REGIONAL CLIMATOLOGY (3)
Prerequisite, GEOG 445, or permission of instructor. Methodology and techniques of collecting and evaluating climatological information. A critical examination of climatic classifications. Distribution of world climates and their geographical implications.

GEOG 450. CULTURAL GEOGRAPHY (3)
Prerequisite, GEOG 201, 202, or consent of instructor. An analysis of the impact of man through his ideas and technology on the evolution of geographic landscapes. Major themes in the relationships between cultures and environments.

GEOG 451. POLITICAL GEOGRAPHY (3)
Geographical factors in national power and international relations; an analysis of the role of "geopolitics" and "geostrategy," with special reference to the current world scene.

GEOG 452. POPULATION GEOGRAPHY (3)
Prerequisite, GEOG 201 or 203, or permission of the instructor. An analysis of world population distribution patterns as revealed by demographic data. Emphasis is placed upon a comparison of population density, growth, composition, and migration with natural resources and state of technological advancement. Case studies from the geographical literature will be used.

GEOG 455. URBAN GEOGRAPHY (3)
Origins of cities, followed by a study of elements of site and location with reference to cities, the patterns and functions of some major world cities will be analyzed. Theories of land use differentiation within cities will be appraised.

GEOG 457. HISTORICAL GEOGRAPHY OF CITIES (3)
The course is concerned with the urbanization of the United States and Canada prior to 1920. Both the evolution of the urban system across the countries and the spatial distribution of activities within cities will be considered. Special attention is given to the process of industrialization and the concurrent structuring of residential patterns among ethnic groups.

GEOG 459. PROSEMINAR IN URBAN GEOGRAPHY (3)
A problems-oriented course for students with a background in urban geography using a discussion/

lecture format. It will focus on a particular sub-field within urban geography each time it is taught, taking advantage of the special interests of the instructor.

GEOG 460. ADVANCED ECONOMIC GEOGRAPHY I—AGRICULTURAL RESOURCES (3)
Prerequisite, GEOG 201 or 203. The nature of agricultural resources, the major types of agricultural exploitation in the world and the geographic conditions. Main problems of conservation.

GEOG 461. ADVANCED ECONOMIC GEOGRAPHY II—MINERAL RESOURCES (3)
Prerequisite, GEOG 201 or 203. The nature and geographic distribution of the principal power, metallic and other minerals. Economic geographic aspects of modes of exploitation. Consequences of geographic distribution and problems of conservation.

GEOG 462. WATER RESOURCES AND WATER RESOURCE PLANNING (3)
GEOG 201 or 203, or permission of instructor. Water as a component of the human environment. A systematic examination of various aspects of water, including problems of domestic and industrial water supply, irrigation, hydroelectric power, fisheries, navigation, flood damage reduction and recreation.

GEOG 463. GEOGRAPHIC ASPECTS OF POLLUTION (3)
The impact of man on his environment and resultant problems. Examination of the spatial aspects of physical and socio-economic factors in air, water, and land pollution.

GEOG 465. GEOGRAPHY OF TRANSPORTATION (3)
The distribution of transport routes on the earth's surface, patterns of transport routes, the adjustment of transport routes and media to conditions of the natural environment, population centers and their distribution.

GEOG 466. INDUSTRIAL LOCALIZATION (3)
Factors and trends in the geographic distributions of the manufacturing industries of the world, analyzed with reference to theories of industrial location.

GEOG 470. HISTORY AND THEORY OF CARTOGRAPHY (3)
The development of maps throughout history. Geographical orientation, coordinates and map scales. Map projections, their nature, use and limitations. Principles of representation of features on physical and cultural maps. Modern uses of maps and relationships between characteristics of maps and use types.

GEOG 471. CARTOGRAPHY AND GRAPHICS PRACTICUM (3)

GEOG 472. PROBLEMS OF CARTOGRAPHIC REPRESENTATION AND PROCEDURE (3)
Two hours lecture and two hours laboratory a week. Study of cartographic compilation methods. Principles and problems of symbolization, classification and representation of map data. Problems of presentation of features at different scales and for different purposes. Place-name selection and lettering, stick-up and map composition.

GEOG 473. PROBLEMS OF MAP EVALUATION (3)
Two hours lecture and two hours laboratory a week. Schools of topographic concepts and practices. Theoretical and practical means of determining map reliability, map utility, and source materials. Nature, status and problems of topographic mapping in different parts of the world. Non-topographic special use maps. Criteria of usefulness for purposes concerned and of reliability.

GEOG 490. GEOGRAPHIC CONCEPTS AND SOURCE MATERIALS (3)
A comprehensive and systematic survey of geographic concepts designed exclusively for teachers. Stress will be placed upon the philosophy of geography in relation to the social and physical sciences, the use of the primary tools of geography, source materials, and the problems of presenting geographic principles.

GEOG 498. TOPICAL INVESTIGATIONS (1-3)
Independent study under individual guidance. Restricted to advanced undergraduate students with credit for at least 24 hours in Geography and to graduate students. Any exception should have the approval of the head of the department.

GEOG 499. UNDERGRADUATE RESEARCH (3)
Directed regional or systematic study involving several subfields of geography, including cartographic presentation, and usually requiring field work, and leading to an undergraduate thesis.

GEOG 600. INTRODUCTION TO GRADUATE STUDY IN GEOGRAPHY (3)
Introduces the student both to research procedures needed in graduate work and to current trends and developments in geographic research. Lectures by various staff members form basic for discussion. Research paper required.

GEOG 601. FIELD COURSE (3)

GEOG 605. QUANTITATIVE SPATIAL ANALYSIS (3)
This course will provide students with a working knowledge of various tools of multivariate analysis in the context of scientific geographic methodology rather than from the statistical theory viewpoint. Emphasis is on the application of statistical tools and a working knowledge of them will be a basis for evaluation of professional literature in the various fields of geography using quantitative techniques. Students should gain a background suitable for using the techniques in research.

GEOG 610. SEMINAR IN GEOGRAPHIC METHODOLOGY (3)
The seminar will emphasize an intensive survey of the basic concepts of geography, a critical evaluation of major approaches to the study of geography, and detailed analysis of the principal methodological problems both theoretical and practical confronting geography today.

GEOG 615. GEOMORPHOLOGY (3)

GEOG 618. SEMINAR IN GEOMORPHOLOGY (3)
Study and discussion of empirical and theoretical research methods applied to geomorphological problems including review of pertinent literature.

GEOG 625. ADVANCED GENERAL CLIMATOLOGY (3)
First semester. Prerequisite, GEOG 260 or consent of instructor. Advanced study of elements and controls of the earth's climates. Principles of climatic classification. Special analysis of certain climatic types.

GEOG 626. APPLIED CLIMATOLOGY (3)
Second semester. Prerequisite, consent of instructor. Study of principles, techniques, and data of micro-climatology, physical and regional climatology relating to such problems and fields as transportation, agriculture, industry, urban planning, human comfort, and regional geographic analysis.

GEOG 628. SEMINAR IN METEOROLOGY AND CLIMATOLOGY (3)
Prerequisite, consent of instructor. Selected topics in meteorology and climatology chosen to fit the individual needs of advanced students.

GEOG 629. SEMINAR IN METEOROLOGY AND CLIMATOLOGY II (3)
See GEOG 628 for description.

GEOG 638, 639. SEMINAR IN PHYSICAL

GEOGRAPHY (3, 3)
Prerequisite, consent of instructor. An examination of themes and problems in the field of physical geography.

GEOG 648, 649. SEMINAR IN CULTURAL GEOGRAPHY (3, 3)
Prerequisite, GEOG 450 or consent of instructor. An examination of themes and problems in the field of economic geography.

GEOG 658. SEMINAR IN HISTORICAL GEOGRAPHY (3)
An examination of themes and problems in historical geography with reference to selected areas. Prerequisite: consent of instructor.

GEOG 668. 669. SEMINAR IN ECONOMIC GEOGRAPHY (3, 3)
Prerequisite, consent of instsructor. An examination of themes and problems in the field of economic geography.

GEOG 678. SEMINAR IN POLITICAL GEOGRAPHY (3)
Beginning with a review of contemporary advanced theory, the seminar will turn to problems such as the spatial consequences of political behavior, the political system and the organization of space including perceived space, the organization of political space. Repeatable to a maximum of six semester hours.

GEOG 679. SEMINAR IN URBAN GEOGRAPHY (3)
Flexible in format to allow adaptation to particular topic being considered, this seminar is for advanced students in the department's metropolitan areas specialty. Students normally will have had the Seminar in Economic Geography. Possible topics include: metropolitan systems, the impact of migrants and immigrants on the internal structure of the city, the delevolpment of black ghettos, the use of particular techniques in urban geographical research.

GEOG 698. SEMINAR IN CARTOGRAPHY (1-16)

GEOG 718, 719. SEMINAR IN THE GEOGRAPHY OF EUROPE AND AFRICA (3, 3)
Prerequisite, GEOG 410, 415 or consent of instructor. Analysis of special problems concerning the resources and development of Europe and Africa.

GEOG 738 739. SEMINAR IN THE GEOGRAPHY OF ASIA (3, 3)
Analysis of problems concerning the geography of East Asia with emphasis on special research methods and techniques applicable to the problems of this area.

GEOG 748, 749. SEMINAR IN THE GEOGRAPHY 0F LATIN AMERICA (3, 3)
Prerequisite, GEOG 431, 432 or consent of instructor. An analysis of recent changes and trends in industrial development, exploitation of mineral resources and land utilization.

GEOG 758, 759. SEMINAR IN THE GEOGRAPHY OF THE U.S.S.R. (3, 3)
Prerequisite, reading knowledge of Russian and GEOG 435 or consent of instructor. Investigation of special aspects of Soviet geography. Emphasis on the use of Soviet materials.

GEOG 768. SEMINAR IN THE GEOGRAPHY OF THE NEAR EAST (3)

GEOG 788. SELECTED TOPICS IN GEOGRAPHY (1-3)
Readings and discussion on selected topics in the field of geography. To be taken only with joint consent of advisor and head of the Department of Geography.

GEOG 789. SELECTED TOPICS IN GEOGRAPHY 1-3)

GEOG 798. READINGS (1-3)
Individual reading as arranged between a graduate faculty member and student. Repeatable to a maximum of six semester hours.

GEOG 799. MASTER'S THESIS RESEARCH (1-6)

GEOG 899. DOCTORAL DISSERTATION RESEARCH (1-8)

GEOLOGY COURSES

GEOL 421. CRYSTALLOGRAPHY (3)
Two lectures and one laboratory a week. Prerequisite, MATH 115 or consent of instructor. An introduction to the study of crystals. Stresses the theoretical and practical relationships between the internal and external properties of crystalline solids. Encompasses morphological, optical and chemical crystallography. (Siegrist)

GEOL 422. MINERALOGY (3)
One lecture and two laboratories a week. Prerequisite, GEOL 110 and 421 or consent of instructor. Basic elementary mineralogy with emphasis on description, identification, formation, concurrence and economic significance of approximately 150 minerals (Siegrist)

GEOL 423. OPTICAL MINERALOGY (3)
One lecture and two laboratories a week. Prerequisite, GEOL 422 or consent of instructor. The optical behavior of crystals with emphasis on the theory and application of the petrographic microscope. (Weidner)

GEOL 431. INVERTEBRATE PALEONTOLOGY (4)
Three lectures and one laboratory a week. Prerequisite, GEOL 102 or consent of instructor. ZOOL 102 or equivalent recommended. A systematic review of the morphology, classification, ecology, and geologic ranges of selected invertebrate groups represented in the fossil record. (Stifel)

GEOL 432. STRATIGRAPHIC PALEONTOLOGY (3)
Two lectures and one laboratory a week. Prerequisite, GEOL 431. Principles of biostratigraphy, paleoecology and paleogeography. Laboratory study emphasizes significant index fossils. (Stifel)

GEOL 434. MICROPALEONTOLOGY (3)
Two lectures and one laboratory a week. Prerequisite, GEOL 431 or consent of instructor. A systematic review of the morphology, classification, ecology and geologic ranges of important microfossil groups, particularly ostracodes and foraminifera. (Stifel)

GEOL 436. REGIONAL GEOLOGY OF NORTH AMERICA (3)
Prerequisite, GEOL 102 or consent of the instructor. A systematic study of the regional geology of North America including history, structure, stratigraphy and petrology of the physiographic provinces of the United States, Canada and the Caribbean. (Wylie)

GEOL 441. STRUCTURAL GEOLOGY (3)
Two lectures and one laboratory a week. Prerequisite, GEOL 110 or consent of instructor. A study of the cause and nature of the physical stresses and resulting deformational responses in the earth. Laboratory exercises include crustal model studies and stereographic analysis of deformational structures. (Segovia)

GEOL 442. SEDIMENTATION (3)
Two lectures and one laboratory a week. Prerequisite, GEOL 110 or consent of instructor. A study of the critical variables in sedimentation systems; origin, dispersion, accumulation, and properties of sediments and sedimentary rocks. Laboratories will include the measurement and statistical analysis of sediment properties and study of sedimentation rates. (Siegrist)

GEOL 443. IGNEOUS AND METAMORPHIC PETROLOGY (2)
Two lectures and two laboratories a week. Prerequisite, GEOL 422 or consent of instructor. A detailed study of igneous and metamorphic rocks: petrogenesis; distributions; chemical and mineralogical relations; macroscopic descriptions and geologic significance. (Weidner)

GEOL 444. PETROGRAPHY (3)
Two lectures and two laboratories a week. Prerequisites, GEOL 423, 442 or consent of instructor. Microscopic thin-section studies of rocks stressing the description and classification of igneous and metamorphic rocks. (Weidner)

GEOL 445. PRINCIPLES OF GEOCHEMISTRY (3)
Three lectures per week. Prerequisite, CHEM 103 or equivalent and senior standing. A survey of historical and modern theories of the origin of elements and their distributions in space, on extraterrestrial bodies and on earth. Discussion of the origin of igeous rocks, of the physical and chemical factors governing development and distribution of sedimentary rocks of the oceans and of the atmosphere. Organic sediments, the internal structures of earth and the planets, the role of isotopes in geothermometry and in the solution of other problems. (Weidner)

GEOL 446. GEOPHYSICS (3)
Two lectures and one laboratory a week. Prerequisite, PHYS 122 or consent of instructor. An introduction to the basic theories and principles of geophysics stressing such important applications as rock magnetism, gravity anomolies, crustal strain and earthquakes, and surveying.

GEOL 451. GROUNDWATER GEOLOGY (3)
Prerequisite, GEOL 100 or consent of instructor. An introduction to the basic geologic parameters associated with the hydrologic cycle. Problems in the accumulation, distribution and movement of groundwater will be analyzed.

GEOL 452. MARINE GEOLOGY (3)
Prerequisite, GEOL 100 or consent of instructor. An introduction to the essential elements of marine and estuarine geology including studies of currents, tides, waves, coastline development, shore erosion and marine and bay sedimentation.

GEOL 453. ECONOMIC GEOLOGY (3)
Prerequisite, GEOL 102 or consent of the instructor Two lectures and one lab a week, the purpose of which is to familiarize students with the ore suites. In addition there will be several field trips. A general survey of metallic and non-metallic ore deposits and the mineral industries stressing configuration of important ore bodies, mineralogical associations, exploration techniques, extraction procedures, and abundance of mineral resources. (Wylie)

GEOL 456. ENGINEERING GEOLOGY (3)
Two lectures and one laboratory a week. Prerequisite, GEOL 110 or consent of instructor. A study of the geological problems associated with the location of tunnels, bridges, dams and nuclear reactors, slope control, and natural hazards. (Segovia)

GEOL 460. EARTH SCIENCE (3)
Two lectures and one laboratory a week. Prerequisite, permission of instructor. An interdisciplinary course designed to show how geology, meteorology, physical geography, soil science, astronomy and oceanography are interrelated in the study of the earth and its environment in space. Recommended for science education undergraduates and graduate students. May not be used for credit towards geology majors. (Layman)

GEOL 462. GEOLOGICAL REMOTE SENSING (3)
One lecture and two laboratories a week. Prere-

quisites, GEOL 441 and 442, or 440, or consent of the instructor. An introduction to geological remote sensing including applications of aerial photographic interpretation to problems in regional geology, engineering geology, structural geology, and stratigraphy. Films, filters, and criteria used in selecting imagery are also discussed. Laboratory exercises include measurements of geologic parameters and compilation and transference of data to base maps. (Segovia)

GEOL 489. SPECIAL TOPICS IN EARTH SCIENCE (1-3)
Prerequisite, GEOL 460 or equivalent. (Layman)

GEOL 499. SPECIAL PROBLEMS IN GEOLOGY (1-3)
Prerequisites, GEOL 102 and 110 or equivalent, and consent of instructor. Intensive study of a special geologic subject or technique selected after consultation with instructor. Intended to provide training or instruction not available in other courses which will aid the student's development in his field of major interest. (Weidner)

GERMANIC LANGUAGE AND LITERATURE PROGRAM

Professor and Chairman: Hering
Professors: Best, Dobert, Hinderer, Jones
Associate Professor: Fleck
Assistant Professors: Elder, Irwin, Knoche, Pfister

The department offers programs in the study of Germanic languages, culture and literature leading to the M.A. and Ph.D. degrees. Specialization is provided in the following areas: Germanic philology, medieval literature and culture, and modern and continental literature.

Admission requirements include a bachelor's degree with an undergraduate major in German or equivalent, and fluency in the written and spoken language.

Degree requirements for the M.A. (thesis option) are 24 hours of coursework, a thesis, and a written comprehensive examination. The M.A. (non-thesis) requires 30 hours of coursework and a written comprehensive examination.

Requirements for the Ph.D. include proficiency in one foreign language (French, Latin or a language required for the candidate's work), philology or applied linguistics coursework, and written comprehensives, dissertation, and oral defense of thesis.

A departmental library of reference works and literary sources is available, and the Library of Congress and The Johns Hopkins University are within easy reach.

GERMAN

GERM 400. BIBLIOGRAPHY AND METHODS (3)
Especially designed for German majors.

GERM 401. ADVANCED COMPOSITION (3)
Translation from English into German, free composition, letter writing.

GERM 402. ADVANCED COMPOSITION (3)
Translation from English into German, free composition, letter writing.

GERM 421, 422. GERMAN CIVILIZATION (IN GERMAN) (3, 3)
Study of the literary, educational, artistic traditions; great men, customs and general culture.

GERM 423, 424. GERMAN CIVILIZATION (IN ENGLISH) (3, 3)
To be offered every second year, alternating with GERM 421, 422, German civilization (in German).

GERM 441, 442. GERMAN LITERATURE OF THE EIGHTEENTH CENTURY (3, 3)
The main works of Klopstock, Wieland, Lessing, Herder, Goethe, Schiller.

GERM 451, 452. GERMAN LITERATURE OF THE NINETEENTH CENTURY (3, 3)
Study of the literary movements from Romanticism to Naturalism.

GERM 461, 462. GERMAN LITERATURE OF THE TWENTIETH CENTURY (3, 3)
Prose and dramatic writings from Gerhart Hauptmann to the present. Modern literary and philosophical movements will be discussed.

GERM 468. 469. PROSEMINAR—SELECTED TOPICS IN GERMAN LITERATURE (3, 3)
Specialized study of one great German writer or of relevant topics of literary criticism.

GERM 471, 472. INTRODUCTION TO GERMANIC PHILOLOGY (3, 3)
An introduction to the study of Indo-European and Germanic philology. Lectures, reading and independent studies.

GERM 488. GERMAN LITERATURE IN TRANSLATION (3)
The development of German literary thought and literary movements in the European context from the enlightenment to the present. Emphasis on the drama and novel in English translation. No previous German course required. May not be counted in fulfillment of German major requirements. Repeatable to a maximum of six credits.

GERM 499. DIRECTED STUDY IN GERMAN (1-3)
For advanced students, by permission of department chairman. Course may be repeated for credit if content differs. May be repeated to a maximum of six credits.

GERM 600. INTRODUCTION TO GERMAN STUDIES (3)

GERM 601. HISTORY OF THE GERMAN LANGUAGE (3)
Covers the generic relationship of the Germanic languages, chronological periods of German. German dialects, syntax (e.g., periphastic tenses, case usage, word order), influences on the language (e.g., early ecclesiastical courtly style, mystical, French, official style. Nazi period), purification process, stylistic periods (Baroque, Classical, Romantic, etc.), special developments (e.g. professional terminology, slang).

GERM 603. GOTHIC (3)
An introduction to historical Germanic linguistics. A grammatical analysis and reading of selections from the Gothic Bible.

GERM 604. OLD HIGH GERMAN (3)
A study of old high German grammar, and readings from the literature of the period.

GERM 605, 606. MIDDLE HIGH GERMAN (3, 3)
Grammar and readings in middle high German literature.

GERM 711, 712. LITERATURE OF THE SIXTEENTH AND SEVENTEENTH CENTURIES (3, 3)
Study of the Reformation, Humanism and the Baroque. The main works of Luther, Sachs, Wickram, Fischart, Opitz, Gryphius, Grimmelshausen.

GERM 745, 746. GOETHE AND HIS TIME (3, 3)
The main works of Goethe and his contemporaries as reflecting the literary development from Rococo to Biedermeier.

GERM 747. SCHILLER (3)
Study of Schiller's works with emphasis on his dramas.

GERM 751. GERMAN ROMANTICISM (3)

GERM 754. THE GERMAN DRAMA OF THE NINETEENTH CENTURY (3)
Kleist, Grabbe, Buchner, Grillparzer, Hebbel, Hauptmann.

GERM 760. THE GERMAN LYRIC (3)
Types of lyrical poetry from "Minnesang" to Symbolism with emphasis on post-Goethean lyricists.

GERM 765. THE GERMAN NOVEL (3)

GERM 766. THE GERMAN NOVEL (3)

GERM 767. SEMINAR IN THE GERMAN NOVELLE (3)

GERM 799. MASTER'S THESIS RESEARCH (1-6)

GERM 818. READING COURSE (3)
Designed to give the graduate student a background of a survey of German literature. Extensive outside readings, with reports and periodic conferences.

GERM 819. READING COURSE (3)
Designed to give the graduate student a background of a survey of German literature. Extensive outside readings, with reports and periodic conferences.

GERM 828. SEMINAR (3)
Topic to be determined.

GERM 829. SEMINAR (3)
Topic to be determined.

GERM 838. SPECIAL TOPICS IN GERMAN LITERATURE (3)
Topic to be determined.

GERM 839. SPECIAL TOPICS IN GERMAN LITERATURE (3)
Topic to be determined.

GERM 899. DOCTORAL DISSERTATION RESEARCH (1-8)

RUSSIAN

RUSS 401. ADVANCED COMPOSITION (3)

RUSS 402. ADVANCED COMPOSITION (3)

RUSS 441. RUSSIAN LITERATURE OF THE EIGHTEENTH CENTURY (3)

RUSS 451. RUSSIAN LITERATURE OF THE NINETEENTH CENTURY (3)

RUSS 452. RUSSIAN LITERATURE OF THE NINETEENTH CENTURY (3)

RUSS 461. SOVIET RUSSIAN LITERATURE (3)

RUSS 462. SOVIET RUSSIAN LITERATURE (3)

RUSS 465. MODERN RUSSIAN POETRY (3)

RUSS 466. MODERN RUSSIAN DRAMA (3)

RUSS 467. MODERN RUSSIAN FICTION (3)

RUSS 470. APPLIED LINGUISTICS (3)
The nature of applied linguistics and its contributions to the effective teaching of foreign languages. Comparative study of English and Russian, with emphasis upon points of divergence. Analysis, evaluation and construction of related drills.

GOVERNMENT AND POLITICS PROGRAM

Professor and Chairman: Piper
Professors: Anderson, Burdette, Dillon, Harrison, Hathorn, Hsueh, Jacobs, McNelly, Murphy, Plischke
Associate Professors: Claude, Conway, Devine, Glendening, Koury, Ranald, Reeves, Stone, Terchek, Wilkenfeld, Wolfe
Assistant Professors: Bechtold, Butterworth, Chaples, Glass, Heisler, Ingles, Kapungu, Lanning, Levine, McCarrick, McGregor, Melnick, Oliver, Strouse, Werlin.
Lecturer: Barber

The Department of Government and Politics offers programs leading to the degrees of Master of Arts and Doctor of Philosophy. Areas of specialization include: American politics, comparative politics, international politics, political behavior, political theory, public administration, and urban affairs.

Master's degree candidates may select a thesis (30 semester credit hours) or a non-thesis option (36 credit hours), both of which require a comprehensive examination in two fields of political science.

The doctoral program is designed for completion within five years and includes seminars, directed research, and opportunities to gain teaching experience. Doctoral students must complete a minimum of 54 hours of course work and may take a concentration in one of the areas of specilization.

In consultation with an adviser each student will prepare, during his first semester, a plan of study to include six hours of political theory and a designation of research tools, which require a demonstration of competence in the use of foreign languages, quantitative research techniques, or a combination of both.

The comprehensive examination encompasses three fields and an oral presentation of the dissertation prospectus. An interdisciplinary curriculum may be presented as one of the fields. The examinations are normally taken after twelve seminars, thereby permitting the student to specialize in terms of a dissertation topic during his final semester.

GVPT 401. PROBLEMS OF WORLD POLITICS (3)
Prerequisite, GVPT 170. A study of governmental problems of international scope, such as causes of war, problems of neutrality, and propaganda. Students are required to report on readings from current literature.

GVPT 402. INTERNATIONAL LAW (3)
Prerequisite, GVPT 170. A study of the basic character, general principles and specific rules of international law, with emphasis on recent and contemporary trends in the field and its relation to other aspects of international affairs.

GVPT 410. PRINCIPLES OF PUBLIC ADMINISTRATION (3)
Prerequisite, GVPT 170. A study of public administration in the United States giving special attention to the principles of organization and management and to fiscal, personnel, planning, and public relations practices.

GVPT 411. PUBLIC PERSONNEL ADMINISTRATION (3)
Prerequisite, GVPT 410 or BSAD 360. A survey of public personnel administration, including the development of merit civil service, the personnel agency, classification, recruitment, examination techniques, promotion, service ratings, training, discipline, employee relations, and retirement.

GVPT 412. PUBLIC FINANCIAL ADMINISTRATION (3)
Prerequisite, GVPT 410 or ECON 450. A survey of governmental financial procedures, including processes of current and capital budgeting, the administration of public borrowing, the techniques of public purchasing, and the machinery of control through pre-audit and post-audit.

GVPT 413. GOVERNMENTAL ORGANIZATION AND MANAGEMENT (3)
Prerequisite, GVPT 410. A study of the theories of organization and management in American government with emphasis on new trends, experiments and reorganizations.

GVPT 414. ADMINISTRATIVE LAW (3)
Prerequisite, GVPT 170. A study of the discretion exercised by administrative agencies, including analysis of their functions, their powers over persons and property, their procedures, and judicial sanctions and controls.

GVPT 417. COMPARATIVE STUDY OF PUBLIC ADMINISTRATION (3)
Prerequisite, GVPT 280, or 410, or consent of instructor. An introduction of the study of governmental administrative systems viewed from the standpoint of comparative typologies and theoretical schemes useful in cross-national comparisons and empirical studies of the politics of the administrative process in several nations. Both Western and Non-Western countries are included.

GVPT 422. QUANTITATIVE POLITICAL ANALYSIS (3)
Prerequisite, GVPT 220, or consent of instructor. Introduction to quantitative methods of data analysis, including selected statistical methods, block analysis, content analysis, and scale construction.

GVPT 426. PUBLIC OPINION (3)
Prerequisite, GVPT 170. An examination of public opinion and its effect on political action, with emphasis on opinion formation and measurement, propaganda and pressure groups.

GVPT 427. POLITICAL SOCIOLOGY (3)
Prerequisite, GVPT 220, or consent of instructor. A study of the societal aspects of political life including selected aspects of the sociology of group formation and group dynamics, political association, community integration and political behavior presented in the context of the societal environments of political systems.

GVPT 429. PROBLEMS IN POLITICAL BEHAVIOR (3)
Prerequisite, GVPT 170. The problem approach to political behavior with emphasis on theoretical and empirical studies on selected aspects of the political process.

GVPT 431. INTRODUCTION TO CONSTITUTIONAL LAW (3)
Prerequisite, GVPT 170. A systematic inquiry into the general principles of the American constitutional system, with special reference to the role of the judiciary in the interpretation and enforcement of the Federal Constitution.

GVPT 432. CIVIL RIGHTS AND THE CONSTITUTION (3)
Prerequisite, GVPT 431. A study of civil rights in the American constitutional context, emphasizing freedom of religion, freedom of expression, minority discrimination, and the rights of defendants.

GVPT 433. THE JUDICIAL PROCESS (3)
Prerequisite, GVPT 170. An examination of judicial organization in the United States at all levels of government, with some emphasis on legal reasoning, legal research and court procedures.

GVPT 434. RACE RELATIONS AND PUBLIC LAW (3)
Prerequisite, GVPT 170. A political and legal examination of the constitutionally protected rights affecting racial minorities and of the constitutional power of the Federal Courts, Congress, and the Executive to define, protect and extend these rights.

GVPT 435. JUDICIAL BEHAVIOR (3)
A study of judicial decision making at the state and national levels, drawing primarily on the more recent quantitative and behavioral literature.

GVPT 441. HISTORY OF POLITICAL THEORY—ANCIENT AND MEDIEVAL (3)
Prerequisite, GVPT 170. A survey of the principal political theories set forth in the works of writers before Machiavelli.

GVPT 442. HISTORY OF POLITICAL THEORY—MODERN AND RECENT (3)
Prerequisite, GVPT 170. A survey of the principal political theories set forth in the works of writers from Machiavelli to J.S. Mill.

GVPT 443. CONTEMPORARY POLITICAL THEORY (3)
Prerequisite, GVPT 441 or 442. A survey of the principal political theories and ideologies from Karl Marx to the present.

GVPT 444. AMERICAN POLITICAL THEORY (3)
Prerequisite, GVPT 170. A study of the development and growth of American political concepts from the Colonial Period to the present.

GVPT 445. RUSSIAN POLITICAL THOUGHT (3)
Prerequisite, GVPT 170. A survey and analysis of poiltical ideas in Russia and the Soviet Union from early times to the present.

GVPT 448. NON-WESTERN POLITICAL THOUGHT (3)
Political thought originating in Asia, the Middle East, and Africa. This is not a survey of all non-Western political thought, but a course to be limited by the professor with each offering. When repeated by a student, consent of instructor is required.

GVPT 450. COMPARATIVE STUDY OF FOREIGN POLICY FORMATION (3)
Prerequisite, GVPT 280 or 300, or consent of instructor. An introduction to the comparative study of foreign policy formation structures and processes followed by a survey of the domestic sources of policy for major states. A conspectus of substantive patterns of foreign policy in analytically salient types of systems is presented. Domestic and global systemic sources of foreign policy are compared.

GVPT 451. FOREIGN POLICY OF THE U.S.S.R. (3)
Prerequisite, GVPT 170. A study of the development of the foreign policy of the Soviet Union, with attention paid to the forces and conditions that make for continuities and changes from Tsarist policies.

GVPT 452. INTER-AMERICAN RELATIONS (3)
Prerequisite, GVPT 170. An analytical and historical study of the Latin-American policies of the United States and of problems in our relations with individual countries, with emphasis on recent developments.

GVPT 453. RECENT EAST ASIAN POLITICS (3)
Prerequisite, GVPT 170. The background and interpretation of recent political events in East Asia and their influence on world politics.

GVPT 454. CONTEMPORARY AFRICAN POLITICS (3)
Prerequisite, GVPT 170. A survey of contemporary development in the international politics of Africa, with special emphasis on the role of an emerging Africa in world affairs.

GVPT 455. CONTEMPORARY MIDDLE EASTERN POLITICS (3)
Prerequisite, GVPT 170. A survey of contemporary development in the international polities of the Middle East, with special emphasis on the role of emerging Middle East nations in world affairs.

GVPT 457. AMERICAN FOREIGN RELATIONS (3)
Prerequisite, GVPT 170. The principles and machinery of the conduct of American foreign relations, with emphasis on the Department of State and the Foreign Service, and an analysis of the major foreign policies of the United States.

GVPT 460. STATE AND LOCAL ADMINISTRATION (3)
Prerequisite, GVPT 170. A study of the administrative structure, procedures and policies of state and local governments with special emphasis on the state level and on intergovernmental relationships, and with ilustrations from Maryland governmental arrangements.

GVPT 461. METROPOLITAN ADMINISTRATION (3)
Prerequisite, GVPT 170. An examination of administrative problems relating to public services, planning and coordination in a metropolitan environment.

GVPT 462. URBAN POLITICS (3)
Urban political process and institutions considered in the light of changing social and economic conditions.

GVPT 473. LEGISLATURES AND LEGISLATION (3)
Prerequisite, GVPT 170. A comprehensive study of legislative organization procedures and problems. The course includes opportunities for student contact with Congress and with the Legislature of Maryland.

GVPT 474. POLITICAL PARTIES (3)
Prerequisite, GVPT 170. A descriptive and analytical examination of American poltical parties, nominations, elections, and political leadership.

GVPT 475. THE PRESIDENCY AND THE EXECUTIVE BRANCH (3)
Prerequisite, GVPT 170. An examination of the executive, legislative and party roles of the president in the political process.

GVPT 479. PROBLEMS OF AMERICAN PUBLIC POLICY (3)
Prerequisite, GVPT 170. The background and interpretation of various factors which affect the formation and execution of American public policy.

GVPT 480. COMPARATIVE POLITICAL SYSTEMS (3)
Prerequisite, GVPT 280 and at least one other course in comparative government. A study, along functional lines, of major political institutions, such as legislatures, executives, courts, bureaucracies, public organizations, and political parties.

GVPT 481. GOVERNMENT AND ADMINISTRATION OF THE SOVIET UNION (3)
Prerequisite, GVPT 170. A study of the adoption of the Communist philosophy by the Soviet Union, of its governmental structure and of the administration of government policy in the Soviet Union.

GVPT 482. GOVERNMENT AND POLITICS OF LATIN AMERICA 3)
Prerequisite, GVPT 170. A comparative study of the

governmental systems and political processes of the Latin American countries, with special emphasis on Argentina, Brazil, Chile, and Mexico.

GVPT 483. GOVERNMENT AND POLITICS OF ASIA (3)
Prerequisite, GVPT 280 or 453, or HIST 261, or 262 or HIFN 442, or 445. A comparative study of the political systems of China, Japan, India and other selected Asian countries.

GVPT 484. GOVERNMENT AND POLITICS OF AFRICA (3)
Prerequisite, GVPT 170. A comparative study of the governmental systems and political processes of the African countries, with special emphasis on the problems of nationbuilding in emergent countries.

GVPT 485. GOVERNMENT AND POLITICS OF THE MIDDLE EAST (3)
Prerequisite, GVPT 170. A comparative study of the governmental systems and political processes of the Middle Eastern countries, with special emphasis on the problems of nation-building in emergent countries.

GVPT 486. COMPARATIVE STUDIES IN EUROPEAN POLITICS (3)
Prerequisite, GVPT 280, or consent of instructor. A comparative study of political processes and governmental forms in selected European countries.

GVPT 487. THE GOVERNMENT AND POLITICS OF SOUTH ASIA (3)
Political systems and governments of such countries as India, Pakistan, Bangla Desh, Ceylon, and Nepal.

GVPT 492. THE COMPARATIVE POLITICS OF RACE RELATIONS (3)
Impact of government and politics on race relations in various parts of the world. The origins, problems, and manifestations of such racial policies as segregation, apartheid, integration, assimilation, partnership, and nonracialism will be analyzed.

GVPT 700. SCOPE AND METHOD OF POLITICAL SCIENCE (3)
Required of all Ph.D candidates. A seminar in the methodologies of political science, and their respective applications to different research fields. Interdisciplinary approaches and bibliographical techniques are also reviewed.

GVPT 702. SEMINAR IN INTERNATIONAL RELATIONS THEORY (3)
An examination of the major approaches, concepts, and theories in the study of world politics with special emphasis on contemporary literature.

GVPT 780. SEMINAR IN THE COMPARATIVE STUDY OF POLITICS (3)
An examination of the salient approaches to and conceptual frameworks for the comparative study of politics, followed by the construction of models and typologies of political systems.

GVPT 799. MASTER'S THESIS RESEARCH (1-6)

GVPT 802. SEMINAR IN INTERNATIONAL LAW (3)
Reports on selected topics assigned for indivdual study and reading in substantive and procedural international law.

GVPT 803. SEMINAR IN INTERNATIONAL POLITICAL ORGANIZATION (3)
A study of the forms and functions of various international organizations.

GVPT 807. FUNCTIONAL PROBLEMS IN INTERNATIONAL RELATIONS—COMPARATIVE SYSTEMS (3)
A survey from Kautilya to Kaplan of the literature in IR Theory with an emphasis on comparative historical systems.

GVPT 808. SELECTED TOPICS IN FUNCTIONAL PROBLEMS IN INTERNATIONAL RELATIONS (3)
An examination of the major substantive issues in contemporary international relations.

GVPT 810. GOVERNMENTAL ORGANIZATION THEORY (3)
A study of recent developments in the area of organizational theory with an emphasis on empirical studies of organizational behavior.

GVPT 812. SEMINAR IN PUBLIC FINANCIAL ADMINISTRATION (3)
Readings and reports on topics assigned for individual or group study in the field of public financial administration.

GVPT 813. PROBLEMS OF PUBLIC PERSONNEL ADMINISTRATION (3)
Reports on topics assigned for individual study and reading in the field of public personnel administration.

GVPT 814. DEVELOPMENTAL PUBLIC ADMINISTRATION (3)
Reports, readings and/or field surveys on topics assigned for individual or group study in international, regional or local environments.

GVPT 815. GOVERNMENT ADMINISTRATIVE PLANNING AND MANAGEMENT (3)
Reports on topics assigned for individual study and reading in administrative planning and management in government.

GVPT 816. STUDIES IN COMPARATIVE GOVERNMENTAL ADMINISTRATION (3)
An examination of theoretical concepts and empirical findings in the field of comparative administration. Individual readings and research dealing with the civil services of Western and Non-Western nations will be assigned.

GVPT 818. PROBLEMS OF PUBLIC ADMINISTRATION (3)
Reports on topics assigned for individual study and reading in the field of public administration.

GVPT 822. PROBLEMS IN QUANTITATIVE POLITICAL ANALYSIS (3)
Prerequisite, three hours of statistics or consent of instructor. Study of selected problems in quantitative political analysis.

GVPT 826. SEMINAR IN PUBLIC OPINION (3)
Reports on topics assigned for individual study and reading in the field of public opinion.

GVPT 828. SELECTED PROBLEMS IN POLITICAL BEHAVIOR (3)
Individual reading and research reports on selected problems in the study of political behavior.

GVPT 830. SEMINAR IN PUBLIC LAW (3)
Reports on topics for individual study and reading in the fields of constitutional and administrative law.

GVPT 840. ANALYTICAL SYSTEMS AND THEORY CONSTRUCTION (3)
Prerequisite, GVPT 700. Examination of the general theoretical tools available to political scientists and of the problems of theory building. Attention is given to communications theory, decision-making, game theory and other mathematical concepts, personality theory, role theory, structural-functional analysis, and current behavioral approaches.

GVPT 841. GREAT POLITICAL THINKERS (3)
Prerequisite, GVPT 441. Intensive study of one or more political theorists each semester.

GVPT 842. MAN AND THE STATE (3)
Prerequisite, GVPT 442. Individual reading and reports on such recurring concepts in political theory as liberty, equality, justice, natural law and natural rights, private property, sovereignty, nationalism and the organic state.

GVPT 844. AMERICAN POLITICAL THEORY (3)
Prerequisite, GVPT 444. Analytical and historical examination of selected topics in American political thought.

GVPT 845. MARXIST POLITICAL THEORY (3)
Prerequisite, GVPT 443 or consent of instructor. Intensive study and analysis of the leading ideas of Marx and Engels and their development in the different forms of Social Democracy and of Communism.

GVPT 846. THEORIES OF DEMOCRACY (3)
Prerequisite, GVPT 442. A survey and analysis of the leading theories of democratic government with attention to such topics as freedom, equality· representation, dissent, and critics of democracy.

GVPT 847. SEMINAR IN NON-WESTERN POLITICAL THEORY (3)
Intensive study of selected segments of political theory outside of the Western European tradition.

GVPT 848. CURRENT PROBLEMS IN POLITICAL THEORY (3)
Prerequisite, GVPT 443. Intensive examination of the development of political theory since the Second World War.

GVPT 851. AREA PROBLEMS IN INTERNATIONAL RELATIONS—SOVIET UNION (3)
An examination of problems in the relations of states involving the Soviet Union.

GVPT 852. AREA PROBLEMS IN INTERNATIONAL RELATIONS—LATIN AMERICA (3)
An examination of problems in the relations of states within Latin America.

GVPT 853. AREA PROBLEMS IN INTERNATIONAL RELATIONS—ASIA (3)
An examination of problems in the relations of states within Asia.

GVPT 854. AREA PROBLEMS IN INTERNATIONAL RELATIONS—AFRICA (3)
An examination of problems in the relations of states within Africa.

GVPT 855. AREA PROBLEMS IN INTERNATIONAL RELATIONS—MIDDLE EAST (3)
An examination of problems in the relations of states within the Middle East.

GVPT 856. AREA PROBLEMS IN INTERNATIONAL RELATIONS—EUROPE (3)
An examination of problems in the relations of states within Europe.

GVPT 857. SEMINAR IN AMERICAN FOREIGN RELATIONS (3)
Reports on selected topics assigned for individual study and reading in American foreign policy and the conduct of American foreign relations.

GVPT 858. SELECTED TOPICS IN AREA PROBLEMS IN INTERNATIONAL RELATIONS (3)
Special topics concerning regional problems in the relations of states.

GVPT 862. SEMINAR ON INTERGOVERNMENTAL RELATIONS (3)
Reports on topics assigned for individual study and reading in the field of recent intergovernmental relations.

GVPT 868. PROBLEMS OF STATE AND LOCAL GOVERNMENT (3)
Report of topics assigned for individual study in the field of state and local government throughout the United States.

GVPT 869. SEMINAR IN URBAN ADMINISTRATION (3)
Selected topics are examined by the team research method with students responsible for planning, field investigation, and report writing.

GVPT 870. SEMINAR IN AMERICAN POLITICAL INSTITUTIONS (3)
Reports on topics assigned for individual study and reading in the background and development of American government.

GVPT 873. SEMINAR IN LEGISLATURES AND LEGISLATION (3)
Reports on topics assigned for individual study and reading about the composition and organization of legislatures and about the legislative process.

GVPT 874. SEMINAR IN POLITICAL PARTIES AND POLITICS (3)
Reports on topics assigned for individual study and reading in the fields of political organization and action.

GVPT 876. SEMINAR IN NATIONAL SECURITY POLICY (3)
An examination of the components of United States security policy. Factors, both internal and external, affecting national security will be considered. Individual reporting as assigned.

GVPT 878. PROBLEMS IN AMERICAN GOVERNMENT AND POLITICS (3)
An examination of contemporary problems in va-

rious fields of government and politics in the United States, with reports on topics assigned for individual study.

GVPT 881. COMPARATIVE GOVERNMENTAL INSTITUTIONS—SOVIET UNION (3)
An examination of government and politics in the Soviet Union.

GVPT 882. COMPARATIVE GOVERNMENTAL INSTITUTIONS—LATIN AMERICA (3)
An examination of governments and politics within Latin America.

GVPT 883. COMPARATIVE GOVERNMENTAL INSTITUTIONS—ASIA (3)
An examination of governments and politics within Asia.

GVPT 884. COMPARATIVE GOVERNMENTAL INSTITUTIONS—AFRICA (3)
An examination of governments and politics within Africa.

GVPT 885. COMPARATIVE GOVERNMENTAL INSTITUTIONS—MIDDLE EAST (3)
An examination of governments and politics within the Middle East.

GVPT 886. COMPARATIVE GOVERNMENTAL INSTITUTIONS—EUROPE (3)
An examination of governments and politics within Europe.

GVPT 887. SEMINAR IN THE POLITICS OF DEVELOPING NATIONS (3)
An examination of the programs of political development in the emerging nations with special references to the newly independent nations of Asia and Africa, and the less developed countries of Latin America. Individual reporting as assigned.

GVPT 888. SELECTED TOPICS IN COMPARATIVE GOVERNMENTAL INSTITUTIONS (3)
An examination of special topics in comparative politics.

GVPT 898. READINGS IN GOVERNMENT AND POLITICS (3)
Guided readings and discussions on selected topics in political science.

GVPT 899. DOCTORAL DISSERTATION RESEARCH (1-8)

HEALTH EDUCATION PROGRAM

Professor and Chairman: Burt
Professors: Johnson, Kenel
Associate Professors: Girdano, Leviton, Miller, Tifft
Assistant Professors: Clearwater, Girdano

The Department of Health Education offers a program designed to prepare students as teachers and community health workers. Graduates of the program have placement opportunities in public school systems, colleges and universities, government service and community health.

The department offers courses of study leading to the degrees of Master of Arts, Doctor of Education and Doctor of Philosophy. Admission is open to students holding the bachelor's degree in areas related to the social, psychological or biological basis of health education.

Each student is required to submit a thesis, to present the work orally in a seminar, and to defend it to the satisfaction of his examining committee. All students must take Health Education 600 and 710.

The proximity of the National Institutes of Health and the National Library of Medicine render the University of Maryland unusually suited for graduate work in health education.

HLTH 420. METHODS AND MATERIALS IN HEALTH EDUCATION (3)
Prerequisites, HLTH 105 or 140, 310 or consent of instructor. The purpose of this course is to present the interrelationships of curriculum planning, methodology and the selection and use of teaching aids and materials. Special problems associated with health teaching are discussed. Students will become familiar with a variety of resources as well as planning for and presenting demonstration lessons.

HLTH 450. HEALTH PROBLEMS OF CHILDREN AND YOUTH (3)
This course involves a study of the health needs and problems of pupils from the primary grades through high school. Physical, mental and psychosomatic aspects of health are considered in relation to the developmental and school levels. Consideration is given to such topics as diet selection and control; exercise, recreation and rest; emotional upset and its implications; and psychosexual development and problems. The role of the teacher and parent in encouraging optimal health is emphasized.

HLTH 455. PHYSICAL FITNESS OF THE INDIVIDUAL (3)
A study of the major physical fitness problems confronting the adult in modern society. Consideration is given to the scientific appraisal, development and maintenance of fitness at all age levels. Such problems as obesity, weight reduction, chronic fatigue, posture, and special exercise programs are explored. This course is open to persons outside the fields of health education.

HLTH 456. HEALTH PROBLEMS OF THE AGING AND THE AGED (3)
Psychological, physiological and socio-economic aspects of aging; nutrition; sexuality; death, dying, and bereavement; self actualization and creativity health needs and crises of the aged.

HLTH 460. PROBLEMS IN SCHOOL HEALTH EDUCATION IN ELEMENTARY AND SECONDARY SCHOOLS (2-6)
A workshop-type course designed particularly for inservice teachers to acquaint them with the best methods of providing good health services, healthful environment and health instruction.

HLTH 470. THE HEALTH PROGRAM IN THE ELEMENTARY SCHOOL (3)
Summer session. Prerequisites, HLTH 105 or 140; 310. This course, designed for the elementary school classrom teacher, analyzes biological and sociological factors which determine the health

status and needs of the individual elementary school child. The various aspects of the school program are evaluated in terms of their role in health education. The total school health program is surveyed from the standpoint of organization and administration, and health appraisal. Emphasis is placed upon modern methods and current materials in health instruction. (The State Department of Education accepts this course for biological science credit.)

HLTH 476. DEATH EDUCATION (3)
The course aims to enable students to better understand aspects of dying so that (1) the quality of their health and living is enhanced and (2) they are better able to help the bereaved, and the dying. The genesis and development of our present day attitudes and behavior are examined using a multidisciplinary and life cycle approach. A field trip and extensive reading and comprehensive research report are required.

HLTH 477. FUNDAMENTALS OF SEX EDUCATION (3)
This course is concerned with basic information regarding the physical, psychological, social, historical, semantic and comparative cultural aspects of sex. The adjustment needs and problems of children and adults during the course of maturing and aging are studied; and special consideration is given to the sex education program in schools.

HLTH 480. MEASUREMENT IN HEALTH (3)
Two lectures and two laboratory periods per week. The application of the principles and techniques of educational measurement to the teaching of health and physical education; study of functions and techniques of measurements in the evaluation of student progress toward the objectives of health and physical education, and in the evaluation of the effectiveness of teaching.

HLTH 488. CHILDREN'S PHYSICAL DEVELOPMENT CLINIC (1-4)
Prerequisite, at least junior standing in Health, Physical Education and Recreation, or by special permission of the director. An opportunity to acquire training and experience in a therapeutically oriented physical education-recreation program for children referred by various education, special education, medical and psychiatric groups.

HLTH 489. FIELD LABORATORY PROJECTS AND WORKSHOP (1-6)
A course designed to meet the needs of persons in the field with respect to workshop and research projects in special areas of knowledge not covered by regularly structured courses. *NOTE:* The maximum total number of credits that may be earned toward any degree in Physical Education, Recreation, or Health Education under PHED, RECR, HLTH or EDUC 489 is six.

HLTH 600. SEMINAR IN HEALTH (1)

HLTH 650. HEALTH PROBLEMS IN GUIDANCE (3)

HLTH 651. SEMINAR ON THE HEALTH CORRELATES OF THE AGING AND THE AGED. (3)
Investigates the most recent theoretical formulations, research data, and clinical and therapeutic approaches to improving the health status of the aging. Extensive readings and research project are required.

HLTH 652. SEMINAR IN DEATH EDUCATION (3)
Prerequsite, HLTH 456 or permission of the instructor. The advanced study and investigation of human dying, death, bereavement, and suicidal behavior, and their relationship to human health utilizing a multidisciplinary approach.

HLTH 670. STATUS AND TRENDS IN HEALTH EDUCATION (3)

HLTH 687. ADVANCED SEMINAR (1-3)

HLTH 688. SPECIAL PROBLEMS IN HEALTH EDUCATION (1-6)

HLTH 690. ADMINISTRATIVE DIRECTION OF HEALTH EDUCATION (3)

HLTH 710. METHODS AND TECHNIQUES OF RESEARCH (3)

HLTH 720. SCIENTIFIC FOUNDATIONS OF HEALTH EDUCATION (3)

HLTH 740. MODERN THEORIES OF HEALTH (3)

HLTH 760. PUBLIC HEALTH (3)

HLTH 791. CURRICULUM CONSTRUCTION IN HEALTH EDUCATION (3)

HLTH 799. MASTER'S THESIS RESEARCH (1-6)

HLTH 899. DOCTORAL DISSERTATION RESEARCH (1-8)

HEARING AND SPEECH SCIENCES PROGRAM

Professor and Chairman: Newby
Associate Professor: Baker
Assistant Professors: Bankson, Doudna, Hamlet, Kumin
Research Professor: Causey
Research Associate Professor: Spuehler
Research Assistant Professor: Elkins
Research Associates: Revoile, Wintercorn

The Department of Hearing and Speech Sciences offers the M.A. degree with either the thesis or the non-thesis option, and with major emphasis either in speech and language pathology or in audiology. The Master's degree is required for individuals preparing for positions as speech pathologists or audiologists in the schools, in hospitals or rehabilitation facilities, in hearing and speech centers, or in other clinical settings. Academic course work is combined with supervised clinical practice in the University Speech and Hearing Clinic and in selected outside clinical facilities, so that the graduate will meet the academic requirements for clinical certification by the American Speech and Hearing Association, and for licensing in the State of Maryland. The Master's degree program is accredited by the American Boards of Examiners in Speech Pathology and Audiology. Applicants for the M.A. degree must have completed the equivalent

of an undergraduate major in hearing and speech sciences.

The Department also offers the Ph.D degree with major emphasis in speech and language pathology, audiology, speech science, or hearing science. Advanced courses in statistics and research design are required of all doctoral candidates. Although no formal minor is required, students are encouraged to take appropriate courses in other departments. The Department does not require proficiency in a foreign language. Course programs for the doctorate are planned by the student and a committee of three faculty members.

The Department's facilities include a biocommunications laboratory with an anechoic chamber, a speech science laboratory, electronics workshop, two 2-room audiology testing suites, and nine therapy rooms equipped for observation. Additional research and clinical facilities are available in the Washington and Baltimore metropolitan areas. The Library of Congress, the National Library of Medicine, and the libraries of the various medical schools in the Washington-Baltimore area supplement the University's library at College Park.

Decisions concerning admission and financial aid are made in March for the summer and fall, and in October for the spring. In addition to the application materials required by the Graduate School, the Department requires applicants to furnish scores on the aptitude portions of the Graduate Record Examination. Additional information about the M.A and Ph.D. programs may be obtained by writing to the Chairman, Department of Hearing and Speech Sciences.

HESP 400. SPEECH AND LANGUAGE DEVELOPMENT OF CHILDREN (3)
Prerequisite, HESP 202. Analysis of normal processes of speech and language development in children.

HESP 401. SURVEY OF SPEECH DISORDERS (3)
For non-majors. Prerequisite, HESP 202. Communication disorders in school children. Graduate credit applicable only in the College of Education.

HESP 403. INTRODUCTION TO PHONETIC SCIENCE (3)
Prerequisite, HESP 202. Phonetic transcription and phonetic principles. Acoustical and perceptual phonetics. (Baker)

HESP 404. SPEECH PATHOLOGY II (3)
Prerequisite, HESP 302, 305. Etiology and therapeutic management of cleft palate and stuttering.

HESP 406. SPEECH PATHOLOGY III (3)
Prerequisite, HESP 302, 305. Etiology and therapeutic management of aphasia and delayed language. (Weiner)

HESP 408. CLINICAL PRACTICE (1-2)
Prerequisite, permission of instructor. Observation and participation in the hearing and speech clinic. Repeatable for a maximum of two credits.

HESP 410. PRINCIPLES AND METHODS IN SPEECH THERAPY (3)
Prerequisite, HESP 404 or 406. Comparative methods in the clinical management of speech problems. (Boss)

HESP 412. REHABILITATION OF THE HEARING HANDICAPPED (3)
Prerequisite· HESP 314. Speechreading, auditory training, and speech training for hard-of-hearing children and adults.

HESP 414. SEMINAR (3)
Prerequisite, permission of instructor. Individual projects in phonetic science, speech pathology, and audiology.

HESP 604. ACOUSTICAL AND PERCEPTUAL PHONETICS (3)
Laboratory techniques in analysis of the acoustical and perceptual characteristics of the speech signal. (Baker)

HESP 606. BASIC HEARING MEASUREMENTS (3)
Prerequisite, HESP 314 or equivalent. Administration and interpretation of hearing tests by pure tones and by speech; screening and clinical test procedures. (Doudna)

HESP 610. APHASIA (3)
Language problems of adults associated with brain injury. (Kumin)

HESP 612. STUTTERING (3) (Bernthal)

HESP 614. OROFACIAL ANOMALIES (3) (Bernthal)

HESP 616. LANGUAGE DISORDERS OF CHILDREN (3) (Bankson)

HESP 620. ARTICULATION DISORDERS (3) (Bankson)

HESP 622. NEUROMOTOR DISORDERS OF SPEECH (3) (Kumin)

HESP 624. VOICE DISORDERS (3) (Hamlet)

HESP 626. DIFFERENTIAL DIAGNOSIS OF NONVERBAL CHILDREN (3)
Evaluation of the nonverbal child.

HESP 634. MEDICAL ASPECTS OF SPEECH AND HEARING DISORDERS (1-3)
Prerequisite, HESP 305 or equivalent and permismission of instructor. Diagnosis and treatment of physical conditions leading to disorders of communication. Guest lecturers. (Doudna)

HESP 638. MINOR RESEARCH PROBLEMS (1-3)
Special projects in speech and hearing science. Repeatable for a maximum of 6 credits.

HESP 640. ADVANCED PRINCIPLES OF SPEECH AND HEARING THERAPY (3)
Analysis of the clinical process with emphasis on the application of learning theory to treatment of speech disorders. (Bankson)

HESP 642. NEUROPHYSIOLOGY OF HEARING (3)
Processing of stimuli by the auditory nervous system.

HESP 648. CLINICAL PRACTICE IN SPEECH (1-3)
Prerequisite, permission of instructor. Supervised training in the application of clinical methods in the diagnosis and treatment of speech disorders. Repeatable for a maximum of 6 credits.

HESP 649. CLINICAL PRACTICE IN AUDIOLOGY (1-3)
Prerequisite, permission of instructor. Supervised training in the application of clinical methods in the diagnosis and treatment of hearing disorders. Repeatable for a maximum of 6 credits.

HESP 700. HEARING AID CHARACTERISTICS AND PERFORMANCE (3)
Electroacoustic characteristics of hearing aids. Methods of hearing-aid evaluation and selection. (Causey)

HESP 702. DIAGNOSTIC PROCEDURES IN SPEECH PATHOLOGY (3)
Diagnostic tools and methods in the analysis of various types of speech disorder. Practicum required. (Weiner)

HESP 704. PHYSIOLOGICAL PHONETICS (3)
Prerequisite, HESP 604. Laboratory techniques in the study of the speech mechanism. (Hamlet)

HESP 706. ADVANCED CLINICAL AUDIOLOGY (3)
Prerequisite, HESP 606 or equivalent. Techniques for evaluation of children and adults presenting special diagnostic problems. (Newby)

HESP 708. INDEPENDENT STUDY (1-6)
Prerequisite, permission of instructor. Individual research projects under guidance of a faculty member. Repeatable for a maximum of 6 credits.

HESP 722. EXPERIMENTAL AUDIOLOGY (3)
Experimental techniques in the investigation of problems in audiology. (Causey)

HESP 724. QUANTITATIVE METHODS IN SPEECH AND HEARING SCIENCE (3)
Prerequisite, a course in basic statistics. Analysis of current procedures used in quantifying phenomena observed in hearing and speech sciences. (Spuehler)

HESP 728. ADVANCED CLINICAL PRACTICE IN SPEECH (1-10)
Prerequisite, previous enrollment in HESP 648 and permission of instructor. Clinical internship in selected off-campus facilities. Repeatable for a maximum of 10 credits.

HESP 729. ADVANCED CLINICAL PRACTICE IN AUDIOLOGY (1-10)
Prerequisite, previous enrollment in HESP 649 and permission of instructor. Clinical internship in selected off-campus facilities. Repeatable for a maximum of 10 credits.

HESP 799. MASTER'S THESIS RESEARCH (1-6)

HESP 804. INSTRUMENTAL PHONETICS (3)
Prerequisites, HESP 604 and 704 or permission of instructor. Instrumental techniques in phonetic science. (Baker, Hamlet)

HESP 806. ADMINISTRATION OF HEARING AND SPEECH PROGRAMS (3)
Problems of staffing, budgeting, and operating training and clinical service programs. (Newby)

HESP 810. EXPERIMENTAL DESIGN IN HEARING AND SPEECH SCIENCES (3)
Prerequisite, HESP 724 or permission of instructor. Design and evaluation of research projects. Preparation for undertaking the doctoral dissertation. (Spuehler)

HESP 820. BIOACOUSTICS (3)
Prerequisite, permission of instructor. Functioning of the hearing mechanism in animals and humans. Laboratory research methods. (Worthington)

HESP 822. PSYCHOACOUSTICS (3)
Prerequisite, permission of instructor. Study of human response to acoustic stimulation. (Causey)

HESP 824. INDUSTRIAL AND ENVIRONMENTAL NOISE PROBLEMS (3)
Prerequisite, permission of instructor. Evaluation and control of noise hazards. Effects of noise on man. Medico-legal aspects of noise-induced hearing impairment. (Newby)

HESP 848. SEMINAR IN AUDIOLOGY (3)
Prerequisite, permission of instructor. Repeatable for a maximum of 6 credits.

HESP 858. SEMINAR IN SPEECH PATHOLOGY (3)
Prerequisite, permission of instructor. Repeatable for a maximum of 6 credits.

HESP 868. SEMINAR IN SPEECH SCIENCE (3)
Prerequisite, permission of instructor. Repeatable for a maximum of 6 credits.

HESP 878. SEMINAR IN LANGUAGE DISORDERS (3)
Prerequisite, permission of instructor. Repeatable for a maximum of 6 credits.

HESP 899. DOCTORAL DISSERTATION RESEARCH (1-8)

HISTORY PROGRAM

Professor and Chairman: Rundell
Professors: Brush,[1] Callcott, Carter, Cole, Duffy, Foust, Gilbert, Gordon, Haber, Harlan, Jashemski, Kent, Merrill, Prange, Schuessler, Smith, Sparks, Yaney
Associate Professors: Belz, Berry, Breslow, Cockburn, Ferrell,[2] Folsom, Giffin, Greenberg, Grimsted, Matossian, Mayo, Olson, Shoufani, Stowasser, Warren
Assistant Professors: Bradbury, Flack, Harris, Hoffman, Kaufman, Lampe, Majeska, McCusker, Nicklason, Perinbam, Robertson, Van Ness, Williams, Wright

[1] joint appointment with Institute for Fluid Dynamics and Applied Mathematics
[2] joint appointment with Secondary Education

The Department of History offers programs leading to the degrees of Master of Arts and Doctor of Philosophy. Areas of specialization include: Ancient, British and British Empire, European History Since the Renaissance, Latin American, Modern Diplomatic, Russian and Soviet, Science and Technology, Third World: African, or East Asian, or Middle Eastern, United States.

The Master of Arts degree serves both as a firm grounding in a field of history for teaching purposes and as preparation for the expeditious pursuit of the doctorate. There are no special admissions requirements for the History Department; it should be noted that an undergraduate major in history is not as such required for admission. Of the thirty credit hours re-

quired for the degree, six are in M.A. thesis research courses (HIST 799), fifteen are normally in the major field of history and nine in a minor (which may be taken within or outside of the department.) The historiography course (HIST 600) is required and may be used as part of the major or minor. Fifteen credit hours at the level of 600 or above are required in addition to the thesis research courses.

A written examination, which is based in large part on a list of books pertaining to the thesis and its field submitted by the student and approved by the advisory committee, is required upon completion of the coursework. There will also be a final oral examination which will be confined to the thesis and the field in which it lies.

Admission to the doctoral program will be decided by the student's M.A. examining committee on the basis of the student's written and oral examinations, thesis, and record of achievement in coursework.

The M.A. degree in history is normally required for admission to the doctoral program, but it does not guarantee admission. Students with M.A. degrees awarded at other institutions will be asked to submit substantial evidence of their written work and will normally be expected to have completed the equivalent of the work required of Maryland M.A. students. Every student must pass a written examination on his major field normally within eighteen months of entry into the doctoral program; this examination will test a broad, intelligent, and informed handling of the major historical problems and literature of that field. A secondary or minor field of study, supportive of the major, is required of all doctoral students; it may be taken within or outside of the department. The minor requirement may be fulfilled by either taking a certain combination of courses, or by passing the regular general written examination in the appropriate field of study, or by having the Master's degree in a major field other than the student's major doctoral field.

The Ph.D. is awarded only for demonstrated excellence on the part of the students as revealed in the written and oral examinations and the dissertation research and writing.

A special field oral examination on the student's dissertation prospectus and a bibliography on the dissertation field is required. The dissertation is to be understood as constituting the largest single portion of the doctoral program; it is expected to be a distinct contribution to historical knowledge and/or interpretation.

All doctoral students must show a reading competence in one foreign language; the language examination must be passed before the student takes the written examination in the major field.

Complete descriptions of these programs and requirements may be obtained from the History Department.

HISTORY

HIST 401. THE SCIENTIFIC REVOLUTION — FROM COPERNICUS TO NEWTON (3)
Major developments in the history of physics and astronomy during the 16th and 17th Centuries and critical evaluations of the Copernican Revolution, the 'mechanical philosophy' of the 17th Century scientists, and the Newtonian Synthesis and its impact on 18th Century thought.

HIST 402. THE DEVELOPMENT OF MODERN PHYSICAL SCIENCE — FROM LAVOISIER TO EINSTEIN (3)
Prerequisites, MATH 110 and PHYS 112 or 117. History of chemistry, physics and geology during the period from about 1775 to about 1925.

HIST 403. HISTORY OF TECHNOLOGY (3)
A survey course designed for junior, senior and graduate students with a solid base in either engineering or history. It will cover the time span from Greek antiquity to the First World War. Technology will be studied as a cultural force controlled by laws of its own and operating within a distinctive conceptual framework. The course will concentrate on the changing character of technology in history and on the interactions between technology and other cultural forces such as science, philosophy, art, material culture, and the economy.

HIST 404. HISTORY OF MODERN BIOLOGY (3)
The internal development of biology from about 1750 to about 1940 will be covered, including evolution, cell theory, genetics, enzymes, and biochemistry, and the origins of anthropology and experimental psychology. The social circumstances under which biology arose and prospered, the philosophical aspects of some debates, the technical achievements enabling new research, and the influences of other sciences on biology will also be discussed.

HIST 405. HISTORY OF EARLY MEDICINE: FROM THAUMATURGY AND THEURGY TO THE 17TH CENTURY THEORIES (3)
A historical survey of the development of medicine in Europe and Asia from earliest times to the Eighteenth Century, Topics discussed include: primitive diseases, Egyptian, Chinese, Greek and medieval medicine, epidemics, surgical developments, and the physician and the development of public health administration. Enrollment limited to upper division and graduate students.

HIST 406. HISTORY OF THE EMERGENCE OF MODERN MEDICINE (3)
Prerequisite, junior standing. Development of modern medicine from the Eighteenth Century to the present with emphasis on the United States, including American Indian medicine, growth of medical professions, hospitals and public health facilities, surgery, clinical medicine, psychiatry and modern medical specialization.

HIST 408. SELECTED TOPICS IN WOMEN'S HISTORY (3)
Prerequisites, HIST 226 or 227 or permission of the instructor. In-depth study of selected topics on women in American society including such areas as women and the law, women and politics, the 'feminine mystique,' and the 'new feminism.' May be repeated to a maximum of six semester hours.

HIST 498. SPECIAL TOPICS IN HISTORY (3)
May be repeated to a maximum of nine hours.

HIST 600. HISTORIOGRAPHY — TECHNIQUES OF HISTORICAL RESEARCH AND WRITING (3)

HIST 685. THE TEACHING OF HISTORY IN INSTITUTIONS OF HIGHER LEARNING (1)

HIST 708. READINGS IN THE HISTORY OF MODERN SCIENCE (3)

HIST 798. SPECIAL TOPICS IN HISTORY (3)

HIST 799. MASTER'S THESIS RESEARCH (1-6)

HIST 808. SEMINAR IN THE HISTORY OF MODERN SCIENCE (3)
Prerequisite, HIST 708 or consent of instructor.

HIST 818. SEMINAR IN HISTORICAL EDITING (3)
An apprenticeship in the editing of documentary sources and scholarly articles for publication. Repeatable to a maximum of six hours.

HIST 868. SEMINAR IN THE HISTORY OF WORLD WAR I (3)

HIST 869. SEMINAR IN THE HISTORY OF WORLD WAR II (3)

HIST 899. DOCTORAL DISSERTATION RESEARCH (1-8)

FOREIGN HISTORY

HIFN 401. THE HISTORY OF SPAIN (3)
Political, social and economic development of Spain; the Spanish empire; Spain's role in Europe. Some attention will be paid to Portuguese history. First semester; 1469-1700.

HIFN 402. THE HISTORY OF SPAIN (3)
Political, social and economic development of Spain; the Spanish empire; Spain's role in Europe. Some attention will be paid to Portuguese history. Second semester: 1700 to present.

HIFN 403. DIPLOMATIC HISTORY OF LATIN AMERICA (3)
A survey of the political, economic and cultural relations of the Latin American nations with emphasis on their relations with the United States and the development of the inter-American system.

HIFN 404. HISTORY OF CANADA (3)
Prerequisite, HIST 241, 242 or 253, 254. A history of Canada, with special emphasis on the Nineteenth Century and upon Canadian relations with Great Britain and the United States.

HIFN 405. HISTORY OF BRAZIL (3)
The history of Brazil with emphasis on the National Period.

HIFN 406. THE HISTORY OF MEXICO AND THE CARIBBEAN TO 1810 (3)
The history of Mexico, Central America and the Antilles, beginning with the pre-Spanish Indian cultures and continuing through the Spanish colonial period and the National Period to the present day. The division point between the two courses is the year 1810, the beginning of the Mexican wars for independence.

HIFN 407. THE HISTORY OF MEXICO AND THE CARIBBEAN, 1810 TO THE PRESENT (3)
The history of Mexico, Central America and the Antilles, beginning with the pre-Spanish Indian cultures and continuing through the Spanish Colonial Period and the National Period to the present day. The division point between the two courses is the year 1810, the beginning of the Mexican wars for independence.

HIFN 410. HISTORY OF ROME (3)
A study of Roman civilization from the earliest beginnings through the Republic and down to the last centuries of the Empire.

HIFN 411. HISTORY OF MEDIEVAL EUROPE (3)
A study of Medieval government, society and thought from the collapse of classical civilization to the Renaissance.

HIFN 412. HISTORY OF MEDIEVAL EUROPE (3)
A study of Medieval government, society and thought from the collapse of classical civilization to the Renaissance.

HIFN 413. THE OLD REGIME AND THE FRENCH REVOLUTION, 1748-1815 (3)
Europe in the era of the French Revolution.

HIFN 414, 415. HISTORY OF EUROPEAN IDEAS (3, 3)
Prerequisites, HIST 241, 242, or 253, 254, or the equivalent. Beginning with a review of the basic Western intellectual traditions as a heritage from the ancient world, the courses will present selected important currents of thought from the scientific revolution of the Sixteenth and Seventeenth Centuries down to the Twentieth Century. First semester, through the Eighteenth Century. Second semester, Nineteenth and Twentieth Centuries.

HIFN 416. THE RENAISSANCE (3)
City-states and the rise of nation-states, the culture and thought of the Renaissance, its impact into the Seventeenth Century.

HIFN 417. THE REFORMATION (3)
Major developments from the 'pre-Reformation' to the 'post-Reformation.' Religion is emphasized as the fundamental motive force resulting in the reformations of the 16th Century. The interaction between religious forces and the political, socio-economic, intellectual, and cultural trends of the period are also considered.

HIFN 420. HISTORY OF THE BRITISH EMPIRE (3)
Prerequisites, HIST 241, 242 or 253, 254. First semester, the development of England's mercantilist empire and its fall in the war for American independence (1783).

HIFN 421. HISTORY OF THE BRITISH EMPIRE (3)
Prerequisite, HIST 241, 242 or 253, 254. Second semester, the rise of the second British Empire and the solution of the problem of responsible self-government (1783-1867), the evolution of the British Empire into a commonwealth of nations, and the development and problems of the dependent empire.

HIFN 422. CONSTITUTIONAL HISTORY OF GREAT BRITAIN (3)
Constitutional development in England, with emphasis on the history of the royal prerogative, the growth of the common law, the development of Parliament, and the emergence of systematized government. First semester, to 1485.

HIFN 423. CONSTITUTIONAL HISTORY OF GREAT BRITAIN (3)
Constitutional development in England, with emphasis on the history of the royal prerogative, the growth of the common law, the development of Parliament, and the emergence of systematized government. Second semester, since 1485.

HIFN 424. HISTORY OF RUSSIA (3)
A history of Russia from earliest times to 1917.

HIFN 425. HISTORY OF RUSSIA (3)
A history of Russia from earliest times to 1917.

HIFN 426. EUROPE IN THE NINETEENTH CENTURY, 1815-1919 (3)
Prerequisites, HIST 241, 242 or 253, 254. A study of the political, economic, social, and cultural development of Europe from the Congress of Vienna to the First World War.

HIFN 427. EUROPE IN THE NINETEENTH CENTURY, 1815-1919 (3)
Prerequisites, HIST 241, 242 or 253, 254. A study of the political, economic, social, and cultural development of Europe from the Congress of Vienna to the First World War.

HIFN 430. EUROPE IN THE WORLD SETTING OF THE TWENTIETH CENTURY (3)
Prerequisites, HIST 241, 242 or 253, 254. A study of political, economic and cultural developments in Twentieth Century Europe with special emphasis on the factors involved in the two World Wars and their global impacts and significance.

HIFN 431. EUROPE IN THE WORLD SETTING OF THE TWENTIETH CENTURY (3)
Prerequisites, HIST, 241, 242 or 253, 254. A study of political, economic and cultural developments in Twentieth Century Europe with special emphasis on the factors involved in the two World Wars and their global impacts and significance.

HIFN 432. THE SOVIET UNION (3)
A history of the Bolshevik Revolution and the founding of the Soviet Union; the economic policy and foreign policy of the U.S.S.R. to the present.

HIFN 433. MODERN FRANCE (3)
A survey of French history from 1815 to the present. The emphasis is upon such topics as the population problem, the economic and social structure of French society, and the changing political and cultural values of this society in response to recurrent crises through the Nineteenth and Twentieth Centuries.

HIFN 434. TUDOR ENGLAND (3)
An examination of the political, religious and social forces in English life, 1485-1603, with special emphasis on Tudor Government, the English Reformation and the Elizabethan Era.

HIFN 435. STUART ENGLAND (3)
An examination of the political, religious and social forces in English life, 1603-1714, with special emphasis on Puritanism and the English Revolutions.

HIFN 436. BRITAIN IN THE 18TH CENTURY (3)
Developments in Great Britain from the Revolution of 1688 to the end of the Napoleonic Wars.

HIFN 437. MODERN BRITAIN (3)
A survey of British history from the age of the French Revolution to World War I with emphasis upon such subjects as Britain's role in the world, the democratization of the state, the problems arising from industrialism and urbanism, and Irish and imperial problems.

HIFN 440. THE EASTERN ORTHODOX CHURCH: ITS CULTURAL HISTORY (3)
A study of the development of the Christian church in the Near East and Eastern Europe from the conversion of Constantine to the present. Emphasis will be on the relations between church and state in various periods and on the influence of Eastern Christianity on the cultures of traditionally Eastern Orthodox nations.

HIFN 442. HISTORY OF CHINA (3)
A history of China from earliest times to the present. The emphasis is on the development of Chinese institutions that have molded the life of the Nation and its people.

HIFN 443. HISTORY OF CHINA (3)
A history of China from earliest times to the present. The emphasis is on the development of Chinese institutions that have molded the life of the Nation and its people.

HIFN 444. THE AGE OF ABOLUTISM, 1648-1748 (3)
Europe in the age of Louis XIV and the Enlightened Despots.

HIFN 445. HISTORY OF JAPAN (3)
Japanese civilization from the age of Shinto mythology, introduction of continental learning, and rule of military overlords.

HIFN 446. HISTORY OF JAPAN (3)
Renewed contact with the Western world and Japan's emergence as a modern state.

HIFN 448. STUDIES IN MIDDLE EASTERN CULTURE (3)
Systematic treatment of aspects of literature and culture of the Middle East. May be repeated.

HIFN 450. THE MIDDLE EAST (3)
A survey of the political, cultural and institutional history covering the period up to the Tenth Century.

HIFN 451. THE MIDDLE EAST (3)
A survey of the political, cultural and institutional history covering the period up from the Tenth Century to the beginnings of the Nineteenth Century.

HIFN 452. THE CONTEMPORARY MIDDLE EAST (3)
This course covers the break-up of the Ottoman Empire and the emergence of contemporary states of the area.

HIFN 454. HISTORY OF THE JEWS AND THE STATE OF ISRAEL (3)
A survey of Jewish history from the Second Century Diaspora to the present with special attention to analysis of Zionism, the creation of a Jewish home in Palestine, the establishment of the state of Israel, and modern developments.

HIFN 455. HISTORY OF ARGENTINA AND THE ANDEAN REPUBLICS (3)
The history of the Nationalist Period of selected South American countries.

HIFN 456. ANCIENT NEAR EAST AND GREECE (3)
A survey of the ancient civilizations of Egypt, the Near East and Greece, with particular attention to their institutions, life, and culture.

HIFN 460. SOCIAL AND CULTURAL HISTORY OF EUROPE (3)
An exploration of social structure, life styles, rituals, symbols, and myths of the peoples of Europe. From earliest times to 1800.

HIFN 461. SOCIAL AND CULTURAL HISTORY OF EUROPE (3)
An exploration of social structure, life rituals, symbols, and myths of the peoples of Europe. The modernization of European society.

HIFN 462. GERMANY IN THE NINETEENTH CENTURY, 1815-1914 (3)
Prerequisites, any one of the following courses: HIST 242, HIFN 421, 426, 427, 433. Junior, senior, or graduate standing required, or consent of instructor. The course is intended to trace the development of modern Germany and provide a basis for the understanding of the rise of National Socialism and Germany in the 20th Century.

HIFN 463. GERMANY IN THE TWENTIETH CENTURY, 1914-1945 (3)
Prerequisites, any one of the following courses: HIST 242, HIFN 421, 426, 427, 433. Junior, senior or graduate standing required, or consent of instructor. The course is intended to provide an understanding of Germany's aims and policies during World War I, her condition and policies in the interwar period, the rise of National Socialism, and Germany's part in World War II.

HIFN 464. NINETEENTH CENTURY EUROPEAN DIPLOMATIC HISTORY (3)
Prerequisite, a course in 19th Century European history. The development and execution of European diplomacy from the Congress of Vienna to the outbreak of World War I, concentrating on Central and Western Europe.

HIFN 465. TWENTIETH CENTURY EUROPEAN DIPLOMATIC HISTORY (3)
Prerequisite, a course in 20th Century European history. The development and execution of European diplomacy from the outbreak of World War I to the conclusion of World War II, concentrating on Central and Western Europe.

HIFN 466. BYZANTINE EMPIRE (3)
Institutions and culture of the Byzantine Empire dealing with the history of the East Roman Empire to the Battle of Manzikert, 1071.

HIFN 467. BYZANTINE EMPIRE (3)
History of Byzantium from 1071 to the fall of Constantinople, 1453.

HIFN 470. EUROPEAN ECONOMIC HISTORY (3)
Economic development of Europe from the manorial economy of Medieval feudalism through the emergence of capitalist institutions and overseas empires to the advent of the industrial revolution.

HIFN 471. EUROPEAN ECONOMIC HISTORY (3)
Begins with 1750 and continues to the present. Emphasis is on causes and consequences of industrial development in Western and Eastern Europe.

HIFN 473. A SURVEY OF AFRICAN HISTORY (3)
A brief survey of the history of sub-Saharan Africa from prehistoric times to the end of the Colonial Era. Special focus on neolithic civilizations, major migrations and political and commercial developments in pre-colonial and Colonial Africa.

HIFN 474. A HISTORY OF WEST AFRICA (3)
HIFN 473 is recommended though not required. A regional study of the western Sudan, forest and coastal regions from prehistoric times to the Nineteenth Century. A discussion of neolithic and iron age civilizations, trans-Saharan and other trade, introduction of Islam, medieval Sudanese empires, forest kingdoms. Nineteenth Century empires and kingdoms, and the impact of European penetration.

HIFN 475. ECONOMIC HISTORY OF WEST AFRICA (3)
The economic history of West Africa from neolithic times to the end of the Colonial Era. Reading knowledge of French desirable.

HIFN 476. MODERN BALKAN HISTORY (3)
A political, socio-economic, and cultural history of Yugoslavia, Bulgaria, Romania, Greece, and Albania from the breakdown of Ottoman domination to the present. Emphasis is on movements for national liberation during the Nineteenth Century and on approaches to modernization in the Twentieth Century.

HIFN 708. READINGS IN LATIN AMERICAN HISTORY (3)
HIFN 728. READINGS IN MEDIEVAL HISTORY (3)

HIFN 729. READINGS IN 17TH CENTURY EUROPEAN HISTORY (3)

HIFN 738. READINGS IN MODERN EUROPEAN INTELLECTUAL HISTORY (3)

HIFN 739. READINGS IN THE HISTORY OF THE RENAISSANCE AND REFORMATION (3)

HIFN 748. READINGS IN THE HISTORY OF GREAT BRITAIN AND THE BRITISH EMPIRE-COMMONWEALTH (3)

HIFN 758. READINGS IN 20TH CENTURY EUROPEAN HISTORY (3)
Readings in 20th Century European history, 1914 to the present. Requirements, reading knowledge of some European language is encouraged, but not required. May be repeated for a maximum of nine semester hours.

HIFN 759. READINGS IN NINETEENTH CENTURY EUROPE (3)

HIFN 768. READINGS IN MODERN RUSSIAN HISTORY (3)

HIFN 778. READINGS IN MODERN FRENCH HISTORY (3)

HIFN 779. READINGS IN MIDDLE EASTERN HISTORY (3)

HIFN 788. READINGS IN JAPANESE HISTORY (3)

HIFN 789. READINGS IN CHINESE HISTORY (3)

HIFN 798. READINGS IN GERMAN HISTORY, 1815 TO THE PRESENT (3)
Reading knowledge of German is encouraged, but not required. May be repeated for a maximum of nine semester hours.

HIFN 808. SEMINAR IN LATIN AMERICAN HISTORY (3)

HIFN 818. SEMINAR IN GREEK HISTORY (3)

HIFN 819. SEMINAR IN ROMAN HISTORY (3)

HIFN 828. SEMINAR IN MEDIEVAL HISTORY (3)

HIFN 829. SEMINAR IN 17TH CENTURY EUROPEAN HISTORY (3)

HIFN 838. SEMINAR IN MODERN EUROPEAN INTELLECTUAL HISTORY (3)

HIFN 839. SEMINAR IN THE HISTORY OF THE RENAISSANCE AND THE REFORMATION (3)

HIFN 848. SEMINAR IN THE HISTORY OF GREAT BRITAIN AND THE BRITISH EMPIRE-COMMONWEALTH (3)

HIFN 849. SEMINAR IN TUDOR AND STUART ENGLAND (3)

HIFN 850. SEMINAR IN ENGLISH LAW AND GOVERNMENT, 1550-1760 (3)
Prerequisites, one of the following courses: HIFN 423, 434, 435, 436 or consent of instructor. From the accession of Elizabeth I to the death of George II.

HIFN 858. SEMINAR IN RUSSIAN HISTORY (3)
HIFN 859. SEMINAR IN NINETEENTH CENTURY EUROPE (3)

HIFN 868. SEMINAR IN 20TH CENTURY EUROPEAN HISTORY (3)
Seminar in 20th Century European history, 1914 to present. Prerequisite: HIFN 758, or consent of instructor.

HIFN 869. SEMINAR IN MODERN EUROPEAN DIPLOMATIC HISTORY (3)
Prerequisite, reading ability of either French or German; a course in modern European history. May be repeated for a maximum of nine semester hours.

HIFN 878. SEMINAR IN MODERN FRENCH HISTORY (3)

HIFN 879. SEMINAR MIDDLE EASTERN HISTORY (3)

HIFN 888. SEMINAR IN JAPANESE HISTORY (3)

HIFN 889. SEMINAR IN CHINESE HISTORY (3)

HIFN 898. SEMINAR IN GERMAN HISTORY, 1815 TO THE PRESENT (3)
Prerequisite, HIFN 798, or consent of instructor. Reading knowledge of German is required. May be repeated to a maximum of six semester hours.

UNITED STATES HISTORY

HIUS 401. AMERICAN COLONIAL HISTORY (3)
The settlement and development of colonial America to the middle of the Eighteenth Century.

HIUS 402. THE AMERICAN REVOLUTION (3)
The background and course of the American Revolution through the formation of the Constitution.

HIUS 403. THE FORMATIVE PERIOD IN AMERICA, 1789-1824 (3)
The evolution of the Federal Government, the origins of political parties, problems of foreign relations in an era of international conflict, beginnings of the industrial revolution in America, and the birth of sectionalism.

HIUS 404. ECONOMIC HISTORY OF THE UNITED STATES (3)
The development of the American economy and its institutions. First semester, to 1865.

HIUS 405. ECONOMIC HISTORY OF THE UNITED STATES (3)
The development of the American economy and its institutions. Second semester, since 1865.

HIUS 406. SOCIAL HISTORY OF THE UNITED STATES (3)
Formation of regional societies: immigration and nativism; the Negro; urban movement; social responses to technological change. First semester, to 1865.

HIUS 407. SOCIAL HISTORY OF THE UNITED STATES (3)
Formation of regional societies; immigration and nativism; the Negro; urban movement; social responses to technological change. Second semester, from 1865.

HIUS 410. THE MIDDLE PERIOD OF AMERICAN HISTORY, 1824-1860 (3)
An examination of the political history of the United States from Jackson to Lincoln with particular emphasis on the factors producing Jacksonian Democracy, manifest destiny, the Whig Party, the Anti-Slavery Movement, the Republican Party, and secession.

HIUS 411. THE CIVIL WAR (3)
Military aspects; problems of the Confederacy; political, social and economic effects of the War upon American society.

HIUS 412. RECONSTRUCTION AND THE NEW NATION, 1865-1896 (3)
Prerequisite, six credits of American history, or permission of instructor. Problems of reconstruction in both South and North. Emergence of big business

and industrial combinations. Problems of the farmer and laborer.

HIUS 413. THE PROGRESSIVE PERIOD — THE UNITED STATES 1896-1919 (3)

HIUS 414. BETWEEN THE WARS — THE UNITED STATES 1919-1945 (3)

HIUS 415. THE UNITED STATES SINCE WORLD WAR II (3)
Problems and issues of American society, foreign and domestic, of the past generation.

HIUS 416. BLACKS IN AMERICAN LIFE—1865 TO THE PRESENT (3)
The role of the black in America since slavery, with emphasis on Twentieth Century developments: the migration from farm to city; the growth of the civil rights movement; the race question as a national problem.

HIUS 420, 421. HISTORY OF THE SOUTH (3, 3)
Prerequisite, HIST 221, 222 or equivalent. The golden age of the Chesapeake, the institution of slavery, the antebellum plantation society, the experience of defeat, the impact of industrialization, and the modern racial adjustment.

HIUS 422. DIPLOMATIC HISTORY OF THE UNITED STATES (3)
A historical study of the diplomatic negotiations and foreign relations of the United States. First semester, from the revolution to 1898. Students who have taken HIST 225 are admitted only by permission of instructor.

HIUS 423. DIPLOMATIC HISTORY OF THE UNITED STATES (3)
A historical study of the diplomatic negotiations and foreign relations of the United States. Second semester, from 1898 to the present. Students who have taken HIST 225 are admitted only by permismission of instructor.

HIUS 424, 425. THE HISTORY OF IDEAS IN AMERICA (3, 3)
A history of basic beliefs about religion, man, nature, and society.

HIUS 426. CONSTITUTIONAL HISTORY OF THE UNITED STATES (3, 3)
A study of the historical forces resulting in the formation of the Constitution, and development of American constitutionalism in theory and practice thereafter.

HIUS 430. HISTORY OF MARYLAND (3)
Political, social and economic history of Maryland from Seventeenth Century to the present.

HIUS 432. A CULTURAL AND SOCIAL HISTORY OF THE AMERICAN WORKER (3)
Examines the free American working class in terms of its composition; its myths and utopias; its social conditions; and its impact on American institutions.

HIUS 433, 434. HISTORY OF THE AMERICAN FRONTIER (3, 3)
Major historical interpretation of the significance to the period of the trans-Allegheny West. Assesses the impact of the frontier experience on American history. Equal attention is given to political, economic, social and cultural problems associated with the development of the West. Indian culture, treatment of the Indians, and Indian-white relations are integrated into the course through readings and lectures.

HIUS 708. READINGS IN COLONIAL AMERICAN HISTORY (3)

HIUS 709. READINGS IN THE AMERICAN REVOLUTION AND THE FORMATIVE PERIOD (3)

HIUS 718. READINGS IN AMERICAN SOCIAL AND ECONOMIC HISTORY (3)

HIUS 719. READINGS IN SOUTHERN HISTORY (3)
HIUS 728. READINGS IN THE MIDDLE PERIOD AND CIVIL WAR (3)

HIUS 729. READINGS IN RECONSTRUCTION AND THE NEW NATION (3)

HIUS 738. READINGS IN RECENT AMERICAN HISTORY (3)

HIUS 739. READINGS IN THE HISTORY OF AMERICAN FOREIGN POLICY (3)

HIUS 748. READINGS IN AMERICAN INTELLECTUAL HISTORY (3)

HIUS 749. READINGS IN AMERICAN CONSTITUTIONAL HISTORY (3)

HIUS 769. READINGS IN THE ECONOMIC HISTORY OF THE UNITED STATES (3)
An examination of the major issues in the history of the economy of the United States from the 17th Century to the present, as these have been discussed by the more important economic historians. Repeatable to a maximum of six hours.

HIUS 808. SEMINAR IN COLONIAL AMERICAN HISTORY (3)

HIUS 809. SEMINAR IN THE AMERICAN REVOLUTION AND THE FORMATIVE PERIOD (3)

HIUS 818. SEMINAR IN AMERICAN SOCIAL AND ECONOMIC HISTORY (3)

HIUS 819. SEMINAR IN SOUTHERN HISTORY (3)

HIUS 828. SEMINAR IN THE MIDDLE PERIOD AND CIVIL WAR (3)

HIUS 829. SEMINAR IN RECONSTRUCTION AND THE NEW NATION (3)

HIUS 838. SEMINAR IN RECENT AMERICAN HISTORY (3)

HIUS 839. SEMINAR IN THE HISTORY OF AMERICAN FOREIGN POLICY (3)

HIUS 848. SEMINAR IN AMERICAN INTELLECTUAL HISTORY (3)

HIUS 849. SEMINAR IN AMERICAN CONSTITUTIONAL HISTORY (3)

HIUS 858. SEMINAR IN AMERICAN LEGAL HISTORY (3)
Repeatable to a maximum of six semester hours.

HIUS 859. SEMINAR IN THE HISTORY OF MARYLAND (3)

HIUS 869. SEMINAR IN THE ECONOMIC HISTORY OF THE UNITED STATES (3)
A research-writing seminar dealing with selected topics in American economic development from the Colonial Period to the present. Repeatable to a maximum of six semester hours.

HORTICULTURE PROGRAM

Professor and Chairman: Stark
Professors: Kramer, Link, Reynolds, Scott, Shanks, Thompson, Twigg, Wiley
Associate Professors: Angell, Baker, Schales, Stadelbacher
Assistant Professors: Beste, Bouwkamp, Wegkamp
Lecturer: Koch (Visiting)

Programs leading to the Master of Science and Doctor of Philosophy degrees are offered by the Department of Horticulture in the fields of pomology, olericulture, floriculture, and ornamental horticulture. Special areas include physiology, genetics, and post-harvest physiology. A non-thesis option is available to master's candidates for whom the M.S. degree will be terminal.

Students seeking admission should present undergraduate preparation in horticulture, botany, chemistry, and supporting agricultural disciplines. Deficiencies must be corrected early in the graduate program. Students are admitted to the doctoral program if it is evident that they can complete the program successfully. The Graduate Record Examination is not required.

HORT 411. TECHNOLOGY OF FRUITS (3)
Three lectures per week. Prerequisite, HORT 112, prerequisite, or concurrent BOTN 441. A critical analysis of research work and application of the principles of plant physiology, chemistry, and botany to practical problems in commercial production (Thompson)

HORT 417. TREE AND SMALL FRUIT MANAGEMENT (1)
Summer session only. Primarily designed for vocational agriculture teachers and extension agents. Special emphasis will be placed upon new and improved commercial methods of production of the leading tree and small fruit crops. Current problems and their solution will receive special attention.

HORT 422. TECHNOLOGY OF VEGETABLES (3)
Three lectures per week. Prerequisite, HORT 222, prerequisite or concurrent, BOTN 441. A critical analysis of research work and application of principles of plant physiology, chemistry, and botany to practical problems in commercial vegetable production. (Reynolds)

HORT 427. TRUCK CROP MANAGEMENT (1)
Summer session only. Primarily designed for teachers of vocational agriculture and extension agents. Special emphasis will be placed upon new and improved methods of production of the leading truck crops. Current problems and their solutions will receive special attention.

HORT 432. FUNDAMENTALS OF GREENHOUSE CROP PRODUCTION (3)
Three lectures per week. Prerequisite, HORT 231. This course deals with a study of the commercial production and marketing of ornamental plant crops under greenhouse, plastic houses and out-of-door conditions.

HORT 451. TECHNOLOGY OF ORNAMENTALS (3)
Three lectures per week. Prerequisite or concurrent, BOTN 441. A study of the physiological processes of the plant as related to the growth, flowering and storage of ornamental plants. (Link)

HORT 453. WOODY PLANT MATERIALS (3)
Prerequisite, BOTN 212. A field and laboratory study of trees, shrubs, and vines used in ornamental plantings. (Baker)

HORT 454. WOODY PLANT MATERIALS (3)
Prerequisite, BOTN 212. A field and laboratory study of trees, shrubs, and vines used in ornamental plantings (Baker)

HORT 456. PRODUCTION AND MAINTENANCE OF WOODY PLANTS (3)
Two lectures and one laboratory period a week. Prerequisite or corequisite, HORT 271, 454. A study of the production methods and operation of a commercial nursery and the planting and care of woody plants in the landscape. (Link)

HORT 457. ORNAMENTAL HORTICULTURE (1)
Summer session only. A course designed for teachers of agriculture and extension agents to place special emphasis on problems of the culture and use of ornamental plants.

HORT 471. SYSTEMATIC HORTICULTURE (3)
Two lectures and one laboratory period a week. A study of the origin, taxonomic relationship and horticultural classification of fruits and vegetables.

HORT 474. PHYSIOLOGY OF MATURATION AND STORAGE OF HORTICULTURAL CROPS (2)
Two lectures a week. Prerequisite, BOTN 441. Factors related to maturation and application of scientific principles to handling and storage of horticultural crops.

HORT 489. SPECIAL TOPICS IN HORTICULTURE (1-3)
Credit according to time scheduled and organization of course. A lecture and/or laboratory series organized to study in depth a selected phase of horticulture not covered by existing courses. A. Horticultural therapy; B. Administration of natural resources; C. Quantitative techniques in environmental design.

HORT 682. METHODS OF HORTICULTURAL RESEARCH (3)
One lecture and one 4-hour laboratory period a week. The application of biochemical and biophysical methods to problems in biological research with emphasis on plant materials.

HORT 689. SPECIAL TOPICS IN HORTICULTURE (1-3)
Credit according to time scheduled and organization of the course. Organized as a lecture series on a specialized advanced topic. B. Pectic substances; C. Plants and light; E. Plant-soil-water relationships.

HORT 699. SPECIAL PROBLEMS IN HORTICULTURE (1-3)
Credit according to time scheduled and organization of the course. Organized as an experimental program other than the student's thesis problem. Maximum credit allowed toward an advanced degree shall not exceed four hours of experimental work.

HORT 781. EDAPHIC FACTORS AND HORTICULTURAL PLANTS (3)
Prerequisite, BOTN 441. A critical study of scientific literature and current research concerning factors of the soil affecting production of horticultural plants. Selected papers are studied and critically discussed. Attention is given to experimental procedures, results obtained, interpretation of the data, and to evaluation of the contribution.
(Reynolds)

HORT 782. CHEMICAL REGULATION OF GROWTH OF HORTICULTURAL PLANTS (3)
Prerequisite, BOTN 441. A critical review of literature and current research relating to the use of chemicals in controlling growth, and useful in the production, ripening, and handling of horticultural plants and products. Emphasis is placed on experimental procedures and the interpretation of results, current usage in the solution of horticultural problems and the potentials for future research.
(Shanks)

HORT 783. ENVIRONMENTAL FACTORS AND HORTICULTURAL PLANTS (3)
Prerequisite, BOTN 441. A study of the literature and a discussion of current research concerned with the effects of environmental factors on the growth and fruiting of horticultural plants. Effects of temperature, light, and atmospheric conditions will be considered. (Thompson)

HORT 784. CURRENT ADVANCES IN PLANT BREEDING (3)
Three lectures per week. Prerequisite, HORT 274 or permission of instructor. Studies of the genetic and cytogenetic basis of plant breeding, systems of pollination control and their application, mutation breeding, methods of breeding for resistance to plant diseases and environmental pollutants.
(Angell)

HORT 798. ADVANCED SEMINAR (1)
Three credit hours maximum allowed toward the M.S. degree or six credit hours maximum toward the Ph.D degree.

HORT 799. MASTER'S THESIS RESEARCH (1-6)

HORT 899. DOCTORAL DISSERTATION RESEARCH (1-8)

HOUSING AND APPLIED DESIGN COURSES

HOUSING

HSAD 440. INTERIOR DESIGN III (4)
Eight hours studio periods. Prerequisite, HSAD 344. Preparation of complete presentation: work specifications, floor plans, purchase orders, renderings, etc. Portfolio preparation.

HSAD 441. INTERIOR DESIGN IV (4)
Prerequisite, HSAD 440. Design problems with emphasis on total environmental approach.

HSAD 442. READINGS IN HOUSING (3)
Seminar. Prerequisites, SOCY 100, HSAD 241, senior standing. To satisfy individual interests and needs. Opportunity is afforded for concentrated reading on one or more facets of housing, (Urban Renewal, public housing, etc.). Examination of completed research, needed future research.

HSAD 488. SELECTED TOPICS IN HOUSING AND INTERIOR DESIGN (1-6)
Offered on demand. May be repeated to a maximum of six hours.

HSAD 499. INDIVIDUAL STUDY IN HOUSING AND/OR INTERIOR DESIGN (3-4)
Guidance for the advanced student capable of independent subject matter investigation or creative work. Problem chosen with consent of instructor.

HSAD 658. SPECIAL TOPICS IN HOUSING AND INTERIOR DESIGN (3-6)
Individual study or arranged group study. May be repeated to a maximum of six hours.

APPLIED DESIGN

APDS 430. ADVANCED PROBLEMS IN ADVERTISING DESIGN (3)
Two studio periods. Prerequisite, APDS 331. Advanced problems in design and layout planned for developing competency in one or more areas of advertising design.

APDS 431. ADVANCED PROBLEMS IN ADVERTISING DESIGN (3)
Two studio periods. Prerequisite, APDS 430. Advanced problems in design and layout planned for developing competency in one or more areas of advertising design.

APDS 437. ADVANCED PHOTOGRAPHY (3)
Three studio periods. Continuation of APDS 337.

APDS 499. INDIVIDUAL PROBLEMS IN APPLIED DESIGN (3-4)
A. Advertising, B. Costume. Open only to advanced students who, with guidance can work independently. Written consent of instructor.

CRAFTS

CRAF 420. ADVANCED CERAMICS II (3)
Three studio periods. Prerequisite, CRAF 330. Experience in experimental development of body and textures, glazes and colors and their utilization in

clay products of original design. Calculation of body and glaze composition.

CRAF 428. INDIVIDUAL PROBLEMS IN CERAMICS (3)
Prerequisites, CRAF 220, 320, 420. Open to students with demonstrated ability and with the potential for a high level of achievement in studio production or in research. Total undergraduate credit permitted in all individual problems courses in crafts is a maximum of nine hours. Consent of crafts faculty. No less than B average on prerequisites and presentation of work for evaluation.

CRAF 430. ADVANCED METALRY II (3)
Two studio periods. Prerequisite, CRAF 330. Advanced application of skills to the design and fabrication of metals; jewelry, stone setting, metal casting, cloisonne, hand-raised hollow ware.

CRAF 438. INDIVIDUAL PROBLEMS IN METALRY (3)
Prerequisites, CRAF 230, 330, 430. Consent of crafts faculty. No less than B average on prerequisites and presentation of work for evaluation. Open to students with demonstrated ability and with the potential for a high level of achievement in studio production or in research. Total undergraduate credit permitted in all individual problems courses in crafts is a maximum of nine hours.

CRAF 448. INDIVIDUAL PROBLEMS IN TEXTILE DESIGN (3)
Prerequisites: CRAF 240, 241, 340 or 341. Consent of crafts faculty. No less than B average on prerequisites and presentation of work for evaluation. Open to students with demonstrated ability and with the potential for a high level of achievement in studio production or in research. Total undergraduate credit permitted in all individual problems courses in crafts is a maximum of nine hours.

HUMAN DEVELOPMENT EDUCATION PROGRAM

INSTITUTE FOR CHILD STUDY

Professor and Director: Morgan
Professors: Chapin, Goering, Kurtz, Perkins
Associate Professors: Dittman, Eliot, Flatter, Gardner, Hardy, Hatfield, Huebner, Kyle, Matteson, Milhollan, Rogolsky
Assistant Professors: Ansello, Bennett, Davidson, Green, Hunt, Shifflett, Tyler, Wolk

The program of the Institute for Child Study attempts to collect, interpret, and synthesize the scientific findings in various fields that are concerned with human growth, development, learning, and behavior, and to communicate this synthesis to persons who need such understandings as a basis for their practice and planning.

A second purpose of the instructional program is to assist persons in education, and secondarily in other professions that deal with human beings, to work out the implications of scientific knowledge for specific situations. Student personnel in Institute courses and programs include teachers; principals; superintendents; counselors; social workers; nurses; psychologists; psychiatric social workers; therapists—physical, speech, and psychological; college teachers of child development; college laboratory teachers; supervisors of curriculum, guidance, in-service projects, etc.

The Institute for Child Study offers graduate programs leading to Master of Education, Master of Arts with thesis, Doctor of Philosophy, and Doctor of Education degrees and Advanced Graduate Specialist Certificate (a planned program of 30 graduate hours beyond the Master's degree). The requirements for these degrees and certificate for those majoring in human development education conform to those of The Graduate School. Master's and Doctor's degree programs in human development are designed to assist the student in gaining competencies in the areas of physiological processes, cultural processes, personality, learning theory, and research methods in human development. A student's program is developed through consultation with an advisor to meet the unique needs of the student. Knowledge of foreign languages is generally not required unless a need for foreign language is indicated in the student's program.

To be admitted to a Master's degree program in human development education an applicant must have a "B" average in the last two years of an undergraduate program from a regionally accredited institution, a grade point average and test scores that are competitive with those of other applicants, and educational and professional goals that are compatible with the purposes and goals of the Institute for Child Study.

Admission to a Doctor's degree program is based upon a profile using the following information: favorable recommendations from at least three professors and/or employers who are acquainted with the applicant's qualifications; a grade point in previous graduate work which is competitive with other applicants; compatibility of the applicant's educational and professional goals with the purposes and goals of the Institute for Child Study; scores on the Miller's Analogies Test (and other standardized tests such as Graduate Record Examination, if available) which are competitive with other applicants; and a Master's degree or equivalent in an allied field from a regionally accredited institution.

The Washington, D.C. area and the University of Maryland are rich in resources for graduate study in human development. The Institute has a special book collection available for use by faculty and students, an in-service program in child and youth study, and opportunities for participating in research. Internship experiences are available through cooperation with mental health agencies and schools in the area. Resources of the College of Education include a Center for Young Children, a Curriculum Materials Center, and an Educational Technology Center. Resources of the Washington metropolitan area include various schools, hospitals, the Office of Education, and the National Institutes of Health of the United States Department of Health, Education, and Welfare.

EDHD 402. CHILD DEVELOPMENT LABORATORY I (2)
First of a series of courses in the direct study of children throughout the school year. Organization

and report of data for group analysis. Provides opportunity for teachers in service to earn credit participation in their own local child study group.

EDHD 403. CHILD DEVELOPMENT LABORATORY II (2)
Prerequisite, EDHD 402 or equivalent. Continuation of EDHD 402. Provides opportunity for teachers in service to earn credit for participation in their own local child study group.

EDHD 404. CHILD DEVELOPMENT LABORATORY III (2)
Prerequisite, EDHD 403 or equivalent. Continuation of EDHD 403. Provides opportunity for teachers in service to earn credit for participation in their own local child study group.

EDHD 411. CHILD GROWTH AND DEVELOPMENT (3)
Growth and development of the child from conception through the early childhood years, with emphasis on development sequences in physical, psychological and social areas. Implications for understanding and working with young children in the home, and other settings.

EDHD 413. ADOLESCENT DEVELOPMENT (3)
A study of the interplay of physical, cultural and self forces as they influence behavior, development, learning and adjustment during adolescence. Includes observation and case study. This course cannot be used to meet the psychological foundations requirements for teacher certification.
(Gardner)

EDHD 416. SCIENTIFIC CONCEPTION IN HUMAN DEVELOPMENT III (3)
Guided reading and observation of pupils throughout the school year. Emphasis on human development concepts relating to impact of family, school, society, and peer group on the student. Collection and analysis of data affecting learning and behavior, For in-service educators. (Not open to persons with credit in EDHD 402, 403.)

EDHD 417. LABORATORY IN BEHAVIOR ANALYSIS III (3)
Prerequisite, EDHD 416. Guided reading and observation of pupils throughout the school year. Emphasis on analysis of intrinsic aspects of learning and behavior including cognitive processes, motivation, self-concept, attitudes, and values. For in-service educators. (Not open to persons with credit in EDHD 402, 403.)

EDHD 420. STUDY OF HUMAN DEVELOPMENT AND LEARNING IN SCHOOL SETTINGS I (2)
Advanced study of human development and learning principles in the continuous study and evaluation of several different phases of the school program over an extended period of time.

EDHD 421. STUDY OF HUMAN DEVELOPMENT AND LEARNING IN SCHOOL SETTINGS II (2)
Continuation of EDHD 420.

EDHD 422. STUDY OF HUMAN DEVELOPMENT AND LEARNING IN SCHOOL SETTINGS III (2)
Continuation of EDHD 421.

EDHD 445. GUIDANCE OF YOUNG CHILDREN (3)
Development of an appreciation and understanding of young children from different home and community backgrounds; study of individual and group problems. (Dittmann)

EDHD 460. EDUCATIONAL PSYCHOLOGY (3)
Prerequisites, PSYC 100 or EDUC 300 or equivalent. Offers an examination of research and problems in educational psychology. Includes consideration of measurement and the significance of individual differences, learning, motivation and emotions, transfer of learning, intelligence, attitudes, problem solving, understanding, thinking, and communicating knowledge. The course is intended to provide an overview of educational psychology with an emphasis on learning processes. It may not be substituted for EDUC 300 by regularly matriculated students in the teacher education program.
(Milhollan)

EDHD 489. FIELD EXPERIENCES IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in which the experience is to be taken. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field experience has been approved by the education faculty. Field experience is offered in a given area to both major and nonmajor students. *Note:* The total number of credits which a student may earn in EDHD 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDHD 498. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDHD 499. WORKSHOPS, CLINICS, AND INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the college of education (or developed cooperatively which other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDHD 600. INTRODUCTION TO HUMAN DEVELOPMENT AND CHILD STUDY (3)
Offers a general overview of the scientific principles which describe human development and behavior and makes use of these principles in the study of individual children. Each student will observe and record the behavior of an individual child throughout the semester and must have one halfday a

week for this purpose. It is basic to further work in child study and serves as a prerequisite for advanced courses where the student has not had field work or at least six weeks of workshop experience in child study. When offered during the summer intensive laboratory work with case records may be substituted for the study of an individual child. (Flatter, Kurtz, Kyle)

EDHD 601. BIOLOGICAL BASES OF BEHAVIOR (3)
EDHD 600 or its equivalent must be taken before EDHD 601 or concurrently. Emphasizes that understanding human life, growth and behavior depends on understanding the ways in which the body is able to capture, control and expend energy. Application throughout is made to human body processes and implications for understanding and working with people. (Chapin)

EDHD 602. SOCIAL BASES OF BEHAVIOR (3)
EDHD 600 or its equivalent must be taken before EDHD 602 or concurrently. Analyzes the socially inherited and transmitted patterns of pressures, expectations and limitations learned by an individual as he grows up. These are considered in relation to the patterns of feeling and behaving which emerge as the result of growing up in one's social group. (Davidson, Hardy)

EDHD 603. INTEGRATIVE BASES OF BEHAVIOR (3)
EDHD 600 or its equivalent. Prerequisites are EDHD 601 and 602. Analyzes the organized and integrated pattern of feeling, thinking and behaving which emerge from the interaction of basic biological drives and potentials with one's unique experience growing up in a social group. (Green)

EDHD 613. ADVANCED LABORATORY IN BEHAVIOR ANALYSIS I (3)
First of a three-course sequence in the study of behavior. Analysis focuses upon the major forces which shape the development and learning of children and youth.

EDHD 615. ADVANCED LABORATORY IN BEHAVIOR ANALYSIS II (3)
Prerequisite: EDHD 613 or equivalent. Second of a three-course sequence in the behavior analysis of children and youth focusing on self-developmental and self adjustive processes. Summer session only.

EDHD 617. ADVANCED LABORATORY IN BEHAVIOR ANALYSIS III (3)
Prerequisite: EDHD 615 or equivalent. Third of a three-course sequence in the behavior analysis of children and youth which contrasts the child's concept of self and the world and the world's concept of the child. Summer session only.

EDHD 619. ADVANCED SCIENTIFIC CONCEPTS IN HUMAN DEVELOPMENT (3)
A critical examination of concepts and issues in contemporary culture as these relate to the development and learning of children and youth. Summer session only. Repeatable to a maximum of six credits.

EDHD 659. DIRECT STUDY OF CHILDREN (1)
May not be taken concurrently with EDHD 402, 403, or 404. Provides the opportunity to observe and record the behavior of an individual child in a nearby school. These records will be used in conjunction with the advanced courses in human development and this course will be used in conjunction with the advanced courses. Teachers active in their jobs while taking advanced courses in human development may use records from their own classrooms for this course. A minimum of one year of direct observation of human behavior is required of all human development students at the Master's level. This requirement may be satisfied by this course. (Morgan)

EDHD 710. AFFECTIONAL RELATIONSHPS AND PROCESSES IN HUMAN DEVELOPMENT (3)
EDHD 600 or its equivalent must be taken before or concurrently. Describes the normal development, expression and influence of love in infancy, childhood, adolescence and adulthood. Deals with the influence of parent-child relationship involving normal acceptance, neglect, rejection, inconsistency, and over-protection upon health, learning, emotional behavior and personality adjustment and development. (Hatfield, Tyler)

EDHD 711. PEER-CULTURE AND GROUP PROCESSES IN HUMAN DEVELOPMENT (3)
EDHD 600 or its equivalent must be taken before or concurrently. Analyzes the process of group formation, role-taking and status-winning, describes the emergence of the 'peer-culture' during childhood and the evolution of the child society at different maturity levels to adulthood. Analyzes the developmental tasks and adjustment problems associated with winning, belonging, and playing roles in the peer group. (Hatfield, Tyler)

EDHD 721. LEARNING THEORY AND THE EDUCATIVE PROCESS I (3)
Provides a systemic review of the major theories and their impact on education. Considers factors that influence learning. (Ansello, Milhollan, Perkins)

EDHD 722. LEARNING THEORY AND THE EDUCATIVE PROCESS II (3)
Prerequisite, EDUC 300 or equivalent. Provides an exploration in depth of current theoretical and research developments in the field of human learning, especially as related to educational processes. Considers factors that influence learning. (Eliot)

EDHD 730. FIELD PROGRAM IN CHILD STUDY I (3)
Prerequisite: consent of instructor. Offers introductory training and apprenticeship preparing persons to become staff members in human development workshops, consultants to child study field programs and coordination of municipal or regional child study programs for teachers or parents. Extensive field experience is provided. In general this training is open only to persons who have passed their preliminary examinations for the Doctorate with a major in Human Development or psychology. (Morgan)

EDHD 731. FIELD PROGRAM IN CHILD STUDY II (3)
Prerequisite: EDHD 730 or consent of instructor. Offers advanced training and apprenticeship pre-

paring persons to become staff members in human development workshops, consultants to child study field programs and coordinators of municipal or regional child study programs for teachers or parents. Extensive field experience is provided. In general this training is open only to persons who have passed their preliminary examinations for the doctorate with a major in human development or psychology. (Morgan)

EDHD 779. SEMINARS IN SPECIAL TOPICS IN HUMAN DEVELOPMENT (2-6)
Prerequisite, consent of instructor.

EDHD 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or Doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number. Course card must have the title of the problem and the name of the faculty member under whom the work will be done.

EDHD 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for Master's thesis.

EDHD 810. PHYSICAL PROCESSES IN HUMAN DEVELOPMENT I (3)
Prerequisite: Admission to doctoral program in human development education. Examines the physiology of homeostasis including the roles of temperature, biochemical factors, respiration, circulation, digestion, and utilization of energy as these influence the health, functioning, and behavior of human beings.

EDHD 811. PHYSICAL PROCESSES IN HUMAN DEVELOPMENT II (3)
Prerequisite: Admission to doctoral program in human development education. Focuses upon the physiology of communication including a study of the roles of the nervous system, endocrines, nucleic acids, and pheramones as these influence the health, functioning and behavior of human beings.

EDHD 820. SOCIALIZATION PROCESSES IN HUMAN DEVELOPMENT I (3)
Prerequisite: Admission to doctoral program in human development education. Study of comparative cultures serves as a medium for analyzing the processes by which human beings internalize the culture of the society in which they live.

EDHD 821. SOCIALIZATION PROCESSES IN HUMAN DEVELOPMENT II (3)
Prerequisite: EDHD 820 or consent of instructor. Study of major subcultures in the United States, their institutions, training procedures, and their characteristic human expressions in folk-knowledge, habits, attitudes, values, goals, and adjustment patterns as these relate to the processes by which human beings in our society internalize the culture in which they live.

EDHD 830. SELF PROCESSES IN HUMAN DEVELOPMENT I (3)
Prerequisite: Admission to doctoral program in human development education. Examines in depth the personality theories of Freud, Jung, Adler, Horney, Fromm, Sullivan, Murray, Lewin, and Allport.

EDHD 831. SELF PROCESSES IN HUMAN DEVELOPMENT (3)
Prerequisite: EDHD 830 or consent of instructor. The personality theories of Erikson, Rogers, Maslow, and others. Synthesis of the student's theory of personality.

EDHD 860. SYNTHESIS OF HUMAN DEVELOPMENT CONCEPTS (3)
Prerequisites, EDHD 810, 820 and 830. A seminar wherein advanced students work toward a personal synthesis of their own concepts in human growth and development. Emphasis is placed on seeing the dynamic interrelations between all processes in the behavior and development of an individual.

EDHD 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeships has been approved by the education faculty. Each apprentice is assigned to work for at least a semester fulltime or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's degree in education, and at least six semester hours in education at the University of Maryland. *NOTE:* The total number of credits which a student may earn in EDHD 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDHD 889. INTERNSHIP IN EDUCATION (3-16)
Internship in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the doctor's degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *NOTE:* The total number of credits which a student may earn in EDHD 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDHD 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an EdD project and 12-18 hours required for a PhD dissertation.

HUMAN ECOLOGY PROGRAM

Associate Professor and Chairman: Gaylin
Professors: Bricker, Brooks
Associate Professors: Lemmon,[1] Myricks, Wilson
Assistant Professors: Brabble, Churaman, Rubin

[1] joint appointment with Secondary Education

A Master's program in Human Ecology is presently offered; however, a proposal for a degree of Master's of Science in Family and Community Development is pending approval.

The program objectives of the Department of Family and Community Development are directed toward training professionals who are prepared to develop and direct a variety of programs and services that are both family-oriented and community based. The areas of specialization in coursework offered within the department are: family studies, community studies with particular emphasis on programs serving families, and management and consumer studies. Faculty members use and encourage an interdisciplinary approach to the study of human problems related to social change and to helping students to become causative agents of change.

Curriculum revisions are in progress; but until such time as the specific graduate programs for the department's new areas of specialization (already in effect in coursework) are officially approved—students will get their Master's degrees in Human Ecology by combining coursework from the Department of Family and Community Development and from other areas of the College and/or campus. Prospective students should consult current schedules of course offerings for full details.

The department recommends that individuals have adequate undergraduate preparation in one or more of the following areas: family development, psychology, sociology, and human ecology. A course in elementary statistics at the undergraduate level is also desirable.

Further information regarding either of these programs should be obtained by contacting the department or the College of Human Ecology directly.

HUMAN ECOLOGY

HUEC 601. METHODS OF RESEARCH IN HUMAN ECOLOGY (3)
Prerequisite, statistics or tests and measurements. Application of scientific methods to problems in the field of human ecology with emphasis on needed research of an inter-disciplinary nature.

HUEC 602. INTEGRATIVE ASPECTS OF HUMAN ECOLOGY (2)
Prerequisite, consent of instructor. Scope and focus of total professional field with emphasis on purpose and functions as related to family and other group living. Impact of the changing social, economic, technological and educational situation upon human ecology.

HUEC 668. SPECIAL TOPICS IN GENERAL HUMAN ECOLOGY (1-6)
Individual study of arranged group study.

HUEC 678. SPECIAL TOPICS IN MANAGEMENT (1-6)
Individual study or arranged group study.

HUEC 688. SPECIAL TOPICS IN FAMILY LIFE (1-6)
Individual study or arranged group study.

A: *Survey of The Family*
The interaction of the family with its own family and the community is reviewed. Family patterns in different social classes and across the family life cycle are emphasized.

HUEC 698. SPECIAL TOPICS IN COMMUNITY SERVICES (1-6)

A: *Community Interaction With Families*
Community organization and structure will be studied from the perspective of (1) individual involvement (2) family involvement (3) intergroup involvement, i.e., racial, ethnic, religious and class groups.

B: *The Family—Community Consultant*
Explores the role and function of the family—community consultant and the consultative process with emphasis on the interaction of various health service disciplines. The ecological, medical, and educational models are examined to ascertain their value as a theoretical framework to help families.

HUEC 799. MASTER'S THESIS RESEARCH (1-6)

FAMILY AND COMMUNITY DEVELOPMENT

FMCD 431. FAMILY CRISES AND DISINTEGRATION (3)
Prerequisite, PSYC 100. A study of significant changes within the family setting which ultimately require major adjustments in inter-personal and intra-personal relations. (Olson)

FMCD 443. CONSUMER PROBLEMS (3)
Consumer practices of American families. Merchandising practices as they affect the consumer. Organizations and laws in the interest of the consumer. (Churaman)

FMCD 446. LIVING EXPERIENCES WITH FAMILIES (3-6)
A. Domestic intercultural, B. International intercultural. Prerequisites, FMCD 330, ANTH 101; EMCD 250; optional, language competence. An individual experience in living with families of a sub-culture within the United States or with families of another country, participating in family and community activities. A foreign student may participate and live with an American family.

FMCD 485. INTRODUCTION TO FAMILY COUNSELING (3)
Prerequisites, PSYC 100 and 235; FMCD 105 and 431. Basic principles of counseling and its effect on family action. (Olson)

FMCD 487. LEGAL ASPECTS OF FAMILY PROBLEMS (3)
Laws and legal involvement that directly affect specific aspects of the family: adoption, marriage,

estate planning, property rights, wills, etc. Emphasis will be given to the involvement of a professional lawyer; principles and interpretation of the law.

FMCD 499. SPECIAL TOPICS (1-3)
A. Family studies, B. Community studies, C. Management and consumer studies.

INDUSTRIAL EDUCATION PROGRAM

Associate Professor and Acting Chairman: Stough
Professors: Harrison, Hornbake, Luetkemeyer, Maley
Associate Professors: Beatty, Mietus, Tierney
Assistant Professors: Anderson, Gelina, Herschbach

The graduate programs in Industrial Education are designed to prepare specialized personnel in all fields related to Industrial Education. These fields include programs both in education and in industry. Programs related to education prepare personnel for teaching, administration, and supervisory positions in local schools or in related state and federal agencies, as well as preparations for university teaching and research. Programs designed for industrial personnel are primarily in industrial training, supervision, and production.

Every graduate program in the department is developed on an individual basis to meet the personal needs of the graduate student. At the same time, however, the graduate student is expected to have achieved certain specified objectives upon completion of his program. The student should exhibit: competence in a major field of Industrial Education; ability to analyze, conduct, and report research findings; and a broad understanding of the relationships of education and industry as social institutions in our technological culture.

At the master's degree level (M.A. and M. Ed.) programs are offered in four areas: Education for Industry, Industrial Arts Education, Vocational-Industrial Education, and Technical Education. The department has two separate doctoral programs (Ph.D. and Ed.D.) in the allied fields of Industrial Arts Education and Vocational-Industrial Education. The department also offers an Advanced Graduate Specialist Certificate in both fields.

In addition to the extensive library and computer facilities available on the College Park Campus, other institutions located within the Washington area are also available for research and consultation services. These institutions include the Library of Congress, Smithsonian Institution, U.S. Office of Education, American Industrial Arts Association, American Vocational Association, and the National Medical Library.

EDIN 409. EXPERIMENTAL ELECTRICITY AND ELECTRONICS (2)

EDIN 415. RESEARCH AND EXPERIMENTATION IN INDUSTRIAL ARTS (3)
This is a laboratory-seminar course designed to develop persons capable of planning, directing and evaluating effective research and experimentation procedures with the materials, products and processes of industry.

EDIN 421. INDUSTRIAL ARTS IN SPECIAL EDUCATION (3)
Four hours laboratory per week, one hour lecture. Prerequisite, EDSP 470 and 471 or consent of instructor. This course provides experiences of a technical and theoretical nature in industrial processes applicable for classroom use. Emphasis is placed on individual research in the specific area of one major interest in special education.

EDIN 425. INDUSTRIAL TRAINING IN INDUSTRY I (3)
An overview of the function of industrial training, type of programs, organization, development and evaluation.

EDIN 426. INDUSTRIAL TRAINING IN INDUSTRY II (3)
Prerequisite, EDIN 425. Studies training programs in a variety of industries, including plant program visitation, training program development, and analysis of industrial training research.

EDIN 443. INDUSTRIAL SAFETY EDUCATION I (2)
This course deals briefly with the history and development of effective safety programs in modern industry and treats causes, effects and values of industrial safety education inclusive of fire prevention and hazard controls.

EDIN 444. INDUSTRIAL SAFETY EDUCATION II (2)
In this course exemplary safety practices are studied through conference discussions, group demonstration, and organized plant visits to selected industrial situations. Methods of fire precautions and safety practices are emphasized. Evaluative criteria in safety programs are formulated.

EDIN 450. TRAINING AIDS DEVELOPMENT (3)
Study of the aids in common use as to their source and application. Special emphasis is placed on principles to be observed in making aids useful to laboratory teachers. Actual construction and application of such devices will be required.

EDIN 457. TESTS AND MEASUREMENTS (3)
The construction of objective tests for occupational and vocational subjects.

EDIN 460. ESSENTIALS OF DESIGN (2)
Two laboratory periods a week. Prerequisite, EDIN 101 and basic laboratory work. A study of the basic principles of design and practice in their application to the construction of laboratory projects.

EDIN 461. PRINCIPLES OF VOCATIONAL GUIDANCE (3)
This course identifies and applies the underlying principles of guidance to the problems of educational and vocational adjustment of students.

EDIN 462. OCCUPATION ANALYSIS AND COURSE CONSTRUCTION (3)
Provides a working knowledge of occupational and job analysis and applies the techniques in building and reorganizing courses of study for effective use in vocational and occupational schools.

EDIN 464. LABORATORY ORGANIZATION AND MANAGEMENT (3)
This course covers the basic elements of organizing and managing an industrial education program including the selection of equipment and the arrangement of the shop.

EDIN 465. MODERN INDUSTRY (3)
This course provides an overview of manufacturing industry in the American social, economic and culture pattern. Representative basic industries are studied from the viewpoints of personnel and management organization, industrial relations, production procedures, distributions of products, and the like.

EDIN 466. EDUCATIONAL FOUNDATIONS OF INDUSTRIAL ARTS (3)
A study of the factors which place industrial arts education in any well-rounded program of general education.

EDIN 467. PROBLEMS IN OCCUPATIONAL EDUCATION (3)
The purpose of this course is to secure, assemble, organize, and interpret data relative to the scope, character and effectiveness of occupational education.

EDIN 471. HISTORY AND PRINCIPLES OF VOCATIONAL EDUCATION (3)
An overview of the development of vocational education from primitive times to the present with special emphasis given to the vocational education movement with the American program of public education.

EDIN 475. RECENT TECHNOLOGICAL DEVELOPMENTS IN PRODUCTS AND PROCESSES (3)
This course is designed to give the student an understanding of recent technological developments as they pertain to the products and processes of industry. The nature of the newer products and processes is studied as well as their effect upon modern industry and/or society.

EDIN 487. FIELD EXPERIENCE IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the major area in which the experience is to be taken. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field experience has been approved by the education faculty. Field experience is offered in a given area to both major and nonmajor students. *Note:* The total number of credits which a student may earn in EDIN 487, 888, and 889 is limited to a maximum of 20 semester hours.

EDIN 488. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDIN 499. WORKSHOPS, CLINICS, AND INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the College of Education (or developed cooperatively with other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDIN 607. PHILOSOPHY OF INDUSTRIAL ARTS EDUCATION (3)
An overview of the development of the industrial arts movement and the philosophical framework upon which it was founded. Special emphasis is given to the contemporary movements in industrial arts and their theoretical foundations.

EDIN 614. SCHOOL SHOP PLANNING AND EQUIPMENT SELECTION (3)
Deals with the principles and problems of providing the physical facilities for industrial education programs. The selection, arrangement and placement of equipment are covered as well as the determination of laboratory space requirements, utility services and storage requirements for various types of industrial education programs.

EDIN 616. SUPERVISION OF INDUSTRIAL ARTS (3)
Deals with the nature and function of the supervisory function in the industrial arts field. The administrative as well as the supervisory responsibilities, techniques, practices and personal qualifications of the industrial arts supervisor are covered.

EDIN 620. ORGANIZATION, ADMINISTRATION AND SUPERVISION OF VOCATIONAL EDUCATION (3)
An examination of the research principles, and practices in the administration of vocational education programs in the community college, technical institute, comprehensive high school, and area vocational school.

EDIN 640. RESEARCH IN INDUSTRIAL ARTS AND VOCATIONAL EDUCATION (2)
Offered by arrangement for persons who are conducting research in the areas of industrial arts and vocational education.

EDIN 641. CONTENT AND METHOD OF INDUSTRIAL ARTS (3)
Various methods and procedures used in curriculum development are examined and those suited to the field of industrial arts education are applied. Methods of and devices for industial arts instruction are studied and practiced.

EDIN 642. COORDINATION IN WORK-EXPERIENCE PROGRAMS (3)
Surveys and evaluates the qualifications and duties of a teacher-coordinator in a work-experience program. Deals particularly with evolving patterns in city and county schools in Maryland, and is designed to help teacher-coordinators, guidance

counselors, and others in the supervisory and administrative personnel concerned with the functioning relationships of part-time cooperative education in a comprehensive educational program.

EDIN 647. SEMINAR IN INDUSTRIAL ARTS AND VOCATIONAL EDUCATION (2)

EDIN 650. TEACHER EDUCATION IN INDUSTRIAL ARTS (3)
This course is intended for the industrial arts teacher educator at the college level. It deals with the function and historical development of industrial arts teacher education. Other areas of content include administration program and program development, physical facilities and requirements, staff organization and relationships, college-secondary school relationships, philosophy and evaluation.

EDIN 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisers may register for credit under this number Course card must have the title of the problem and the name of the faculty member under whom the work will be done.

EDIN 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for master's thesis.

EDIN 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's Degree in education, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDIN 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDIN 889. INTERNSHIP IN EDUCATION (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the Doctor's Degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *Note:* The total number of credits which a student may earn in EDIN 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDIN 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an EdD project and 12-18 hours required for a Ph.D. dissertation.

INFORMATION SYSTEMS MANAGEMENT COURSES

IFSM 401. ELECTRONIC DATA PROCESSING (3)
Prerequisites, junior standing, MATH 111 or the equivalent. The electronic digital computer and its use as a tool in processing data. The course includes the following areas: (1) organization of data processing systems, (2) environmental aspects of computer systems (3) management control problems and potentials inherent in mechanized data processing systems.

IFSM 402. ELECTRONIC DATA PROCESSING APPLICATIONS (3)
Prerequisites, IFSM 401 and BSAD 230, or consent of instructor. Intensive study of computer applications using a problem-oriented language. Introduction of computer methods for the solution of organizational problems. Laboratory exercises in programming and development of computer techniques.

IFSM 410. INFORMATION PROCESSING PROBLEMS OF MODELS OF ADMINISTRATIVE, ECONOMIC AND POLITICAL SYSTEMS (3)
Prerequisites, MATH 141 or equivalent; EFSM 402, BSAD 230, and some familiarity with administrative, economic and/or political models. Prerequisites may be waived with the consent of instructor. Data processing requirements underlying the creation and maintenance of a data base to be used in estimating the parameters of socio-economic models. An analysis of the structure and development of recent socio-economic models as relevant to data processing considerations. Extractions and preparation of data from the data base to facilitate the appropriate transformation necessary for model construction and also to minimize the processing cost of data in-put. The course draws upon a knowledge of models of administrative, economic and political systems. Case studies and experience with data processing for selected models are included.

IFSM 420. INFORMATION PROCESSING AND COMPUTATIONAL PROBLEMS IN OPERATIONS ANALYSIS (3)
Prerequisites, MATH 141 or equivalent; IFSM 402, and a course in statistics, such as BSAD 432, dealing with multivariate models. Prerequisites may be waived with the consent of the instructor. Implementation of applications requiring the integration of data processing and analytical programming techniques. Such applications feature the calculation of various statistical estimates of the parameters in a multivariate model within the context of a file maintenance problem (e.g., the writing of a matrix inversion routine for revenue forecasting within a master updating program or sales fore-

casting and/or sales performance evaluation within a sales transaction-master updating program). A universal, problem-oriented language such as COBOL will be used with strong emphasis on the use of the mathematical Fortran IV library subroutines. Class projects include case studies and solutions of problems using real-world data.

IFSM 436. INTRODUCTION TO SYSTEMS ANALYSIS (3)

Prerequisites, IFSM 102, BSAD 330, MATH 141, or the equivalent. Prerequisites may be waived with consent of instructor. The use of the computer in the management and operation of organizations. The course includes the following areas: (1) the principles of systems analysis, (2) recent applications and innovations of the systems concept, (3) design and implementation of computer systems, including such techniques as mathematical programming, simulation, business games and network analysis, and (4) laboratory use of a digital computer in the application of these techniques.

IFSM 610. DESIGN OF LARGE-SCALE INFORMATION PROCESSING SYSTEMS (3)

Prerequisites, IFSM 410 and 436 or consent of instructor. Characteristics of large-scale information processing systems. Relationship of model-building and simulation to information processing system design. Design elements and phases. Programming techniques for large-scale information processing systems, including time sharing and real-time. Special projects include case studies and the design of a large-scale information processing system.

IFSM 620. MANAGEMENT OF INFORMATION PROCESSING SYSTEMS (3)

Prerequisite, IFSM 436 or consent of instructor. Administrative uses and limitations of high-speed computers in an information processing system. Limitations as related to system structure and methods used to originate and process data. Planning and installation of a total information processing system including conversion problems. Measures of information processing effectiveness. Documentation procedures. Data security, legal considerations and auditing the information processing system. Personnel requirements for an on-going system. The broad statement of the system requirements is taken as given.

IFSM 630. APPLICATION OF ADVANCED DEVELOPMENTS IN INFORMATION PROCESSING (3)

Prerequisite, IFSM 610 or consent of instructor. A study and an evaluation of the operational and hardware characteristics of the computer and peripheral equipment available to meet the specification of the broad classes of information processing systems, including coding systems, error-decting and software considerations. Data communicating devices, including the functional characteristics of long-line, telephone channel, transceiver and communication satellites. Case studies and examples.

JOURNALISM PROGRAM

Professor and Dean: Hiebert
Professors: Martin, Newsom
Associate Professors: Brown, Grunig
Assistant Professors: Lee, Petrick

The Master of Arts degree in Journalism provides academic work both for the young person who wants a professional career in communication and for the student interested in mass communication theory and research methodology. The first type of student usually builds on a news-editorial background, adding in-depth work in a substantive minor field, as preparation for a career as a reporter or editor for the news media. The second type of student usually builds on a social science base coupled with the study of journalism or mass communication while preparing for a career in teaching, scholarship, or applied research in advertising, public relations, opinion research, or similar areas concerned with mass communication. The Master's degree is a one-year program, with the typical student taking 12 hours of graduate work in the fall, 12 hours in the spring, and 6 hours of thesis or thesis-option seminars in the summer. The program is best suited but not limited to students who have completed an undergraduate major in journalism, with a strong minor in the social sciences.

Applicants seeking admission to the Master's program should hold a Bachelor's degree from a recognized institution of higher learning. Undergraduate study of journalism or professional experience in journalistic fields are helpful but not required. Completion of the general aptitude portion of the Graduate Record Examination is required, and three letters of recommendation must be submitted.

The College of Journalism offers a number of assistantships, varying in amounts from $2900 to $3500, usually including exemptions from tuition and fees. Students awarded such assistantships usually pursue full-time study while engaged in teaching or research assistance in journalism for 15 to 20 hours per week.

The University of Maryland is in an advantageous location for the study of journalism. It is within easy reach of five of the nation's top newspapers: the Baltimore *Sun,* Baltimore *News-American, The Washington Post, The Evening Star,* and *Wall Street Journal.* It is also near the Washington press corps, the large Washington bureaus of the Associated Press, United Press International, the New York *Times,* and most important American and foreign newspapers; NBC, CBS, and ABC, and other broadcasting news bureaus; and news magazines and major book publishing offices. It is at the doorstep of the nation's major newsmakers in the executive, legislative, and judicial branches of the Federal Government.

Special facilities include photographic, news editing, and advertising laboratories, as well as a reading room with daily and weekly newspapers, magazines, and files for miscellaneous clippings and bulletins.

JOUR 400. LAW OF MASS COMMUNICATION (3)
Study of the legal rights and constraints of mass media libel, privacy, copyright, monopoly, and contempt, and other aspects of the law applied to mass communication. Previous study of the law not required. Prerequisites, JOUR 200 and 201.

JOUR 410. HISTORY OF MASS COMMUNICATION (3)
Study of the development of newspapers, magazines, radio, television, and motion pictures as media of mass communication. Analysis of the influences of the media on the historical development of America. Prerequisites, JOUR 200 and 201.

JOUR 420. GOVERNMENT AND MASS COMMUNICATION (3)
Study of the relationship between the news and government. Analysis of media coverage of government and politics. Study of governmental and political information and persuasion techniques. Prerequisites, JOUR 200 and 201.

JOUR 430. COMPARATIVE MASS COMMUNICATION SYSTEMS (3)
Survey of the history and status of the mass media throughout the world; comparative analysis of the role of the press in different societies. Prerequisites, JOUR 200 and 201 or consent of the instructor for non-majors.

JOUR 440. PUBLIC OPINION AND MASS COMMUNICATION (3)
Study of publics and their interrelationships in the formation of public opinion; measurement of public opinion and media habits; role of the mass media in the formation of public opinion. Prerequisites, JOUR 200 and 201.

JOUR 490. SEMINAR IN JOURNALISM (3)
Seminar for journalism seniors in newsroom problems and policies, emphasizing ethics and responsibilities; in cooperation with the Baltimore *Sun,* Baltimore *News-American,* and other area news media. Prerequisite, permission of the instructor.

JOUR 497. SUPERVISED INTERNSHIP (1)
Summer session. To be taken following junior year as major in this department, permission of instructor. Ten weeks of organized, supervised study, experience, on-the-job training in journalism.

JOUR 499. PROBLEMS IN JOURNALISM (1-3)
Individual projects in journalism, including internships. May be repeated to a maximum of three hours.

JOUR 600. RESEARCH METHODS IN MASS COMMUNICATION (3)
Introduction to the methods of empirical research on mass communications; the scientific method, elements of experimental design and survey techniques, content analysis, readership and readability studies, audience measurement, and analysis of quantitative data. Prior work in statistics recommended. Required of all graduate students.

JOUR 610. SEMINAR IN MASS MEDIA AND SOCIETY (3)
Analysis and discussion of the interrelationships between the mass media and society, including various social and cultural elements of modern society; responsibilities of the mass media and the mass communicator.

JOUR 612. THEORIES OF MASS COMMUNICATION (3)
Survey and evaluation of current theories of mass communication. Attention is given to the nature and function of scientific theory, models of communication behavior, the nature of information, social functions of mass communications, attitude change and persuasive communication, and theories of language and meaning.

JOUR 620. SEMINAR IN PUBLIC AFFAIRS REPORTING (3)
Washington, including the White House, Congress, Supreme Court, and Executive Departments, and city, county, and state government centers are used as laboratories for advanced study of and practice in depth reporting, investigation, and interpretation of public affairs. Students meet in seminar with news sources and newsmen, and participate in live news coverage.

JOUR 621. INTERPRETATION OF CONTEMPORARY AFFAIRS (3)
Advanced training in the preparation, researching, and writing of articles, backgrounders, columns, editorials, and documentaries for the mass media; press conferences with news sources; emphasis on thorough familiarity with subject matter and responsible interpretation.

JOUR 630. SEMINAR IN CORPORATE COMMUNICATIONS (3)
Study of communication problems of corporations within industrial society, including intraorganizational communication and public communication with various publics. Evaluation of corporate communication tools used in public relations and advertising. Special attention to corporate communication problems such as pollution, community responsibility, and economic education.

JOUR 640. MASS CULTURE AND MASS COMMUNICATION (3)
Study of the relationship of mass culture to mass communication; investigation of historical and empirical data concerning mass culture and the mass media.

JOUR 700. SEMINAR IN MASS MEDIA LAW (3)
Individual projects concerning legal problems in freedom and responsibilities of the mass media; problems of libel, privacy, censorship, contempt, and the relationship of media laws to current social standards and mores; trends in legal interpretations and standards of judgment.

JOUR 710. SEMINAR IN MASS MEDIA HISTORY (3)
Individual projects in mass communication history, including use of quantitative methods in historical research, analysis of historical literature of journalism, and individual study of men, media, technology, and trends in communication.

JOUR 720. SEMINAR IN GOVERNMENT AND MASS COMMUNICATION (3)
Intensive study of and individual projects concerning the relationship between the mass media and governmental and political agencies; the role of the press in reporting government and politics; the process and effects of government information and political propaganda.

JOUR 721. SEMINAR IN URBAN MASS COMMUNICATION (3)
Intensive study of and individual projects concerning the special problems of mass communication within the urban community, including the reporting of urban affairs by the mass media, and the effects of mass communication on urban problems.

JOUR 730. SEMINAR IN COMPARATIVE MASS COMMUNICATION (3)
Study of world news communication systems, including news gathering agencies, the role of foreign correspondents, the mass media in developing and developed nations, and factors determining the flow of world news and government international information.

JOUR 731. CROSS-CULTURAL COMMUNICATION (3)
Analysis discussion of cross-cultural communication problems, including the role of social, cultural, psychological, semantic and psycholinguistic barriers to communication across cultures; effects of mass communications in cross-cultural situations. Consent of instructor required.

JOUR 799. MASTER'S THESIS RESEARCH (1-6)

JOUR 800. SEMINAR IN CRITICAL ANALYSIS (3)
Individual projects in appraising the mass media and their performance, including examination of personal values, societal values, media codes, ethics, and practices.

JOUR 810. SPECIAL PROBLEMS IN COMMUNICATION (3)
Topics and assignments to be arranged.

JOUR 812. SEMINAR IN COMMUNICATION THEORIES (3)
Individual projects in the detailed examination of a particular area of communication theory. Evaluation of existing theory and research, suggesting hypotheses and formulating proposals for future research.

LIBRARY AND INFORMATION SERVICES PROGRAM

Professor and Dean: Chisholm
Professors: Bundy, Heilprin,[1] Kidd, Olson, Reynolds, Wasserman
Associate Professors: Dubester, Liesener, Soergel
Assistant Professors: Bates, Kennelly, Kraft, Lukenbill

[1] joint appointment with Computer Science

The goal of the program in Library and Information Services is to provide professional education at the graduate level within the university setting. It endeavors to establish a position in the forefront of instructional and theoretical inquiry to influence the vanguard of practice in librarianship.

Although no specific undergraduate courses are required for admission to the program, those who seek admission must have completed a broad arts and sciences program with strength in the humanities, social sciences, and physical or biological sciences.

Faculty advisors recommend courses they think most appropriate for each student. The required proseminar and introductory courses in the organization of knowledge and reference provide a base from which the student can build a purposeful program fitted to his personal needs and aspirations. Reflecting the multi-disciplinary nature of librarianship and its continuing need for reliance upon insights from supportive intellectual disciplines, students have a high degree of flexibility in the elective portions of their work. Their courses are not restricted to those within the program but can include relevant courses from other parts of the University.

The Master of Library Science degree will be awarded to the student who successfully completes a program of 36 hours with an average or "B" within three years from his first registration in the program. Under a full-time program a student normally completes 15 semester hours during the fall and spring semesters and 6 hours during the summer terms. A number of qualified part-time students are also admitted to the program. Such students are expected to pursue a minimum of two courses during each semester. No thesis or comprehensive examination is required.

The Ph.D. program requires the equivalent of three years of full-time work, normally divided into approximately two years of formal coursework (60 semester hours) and one year of research on the dissertation.

LBSC 499. WORKSHOPS, CLINICS, AND INSTITUTES (1-9)
Workshops, clinics, and institutes developed around specific topics or problems primarily for practicing librarians. Repeatable to a maximum of nine credit hours.

LBSC 600. PROSEMINAR—THE DEVELOPMENT AND OPERATION OF LIBRARIES AND INFORMATION SERVICES (3)
Background and orientation needed for advanced study in librarianship and information science. Covers the major problems in the development and provision of information services; the structure, functions, and economics of information service organizations; and the processes by which change is brought about in the quality of information services.

LBSC 610. INTRODUCTION TO REFERENCE AND BIBLIOGRAPHY (3)
A systematic approach to bibliographic control of recorded knowledge and the methods of securing information from various types of sources.

LBSC 613. LITERATURE AND RESEARCH IN THE SCIENCES (3)
Bibliographic organization, information structure and trends in the direction of research in the principal scientific disciplines.

LBSC 615. LITERATURE AND RESEARCH IN THE SOCIAL SCIENCES (3)
Bibliographic organization, information structure and trends in the direction of research in the principal fields of the social sciences.

LBSC 617. LITERATURE AND RESEARCH IN THE HUMANITIES (3)
Bibliographic organization, information structure

and trends in the direction of research in the principal humanistic disciplines.

LBSC 620. MEDICAL LITERATURE AND LIBRARIANSHIP (3)
Introduction to medical literature and its reference sources, stressing those aspects of the field of medicine which lead to special characteristics in the organization and handling of its literature and innovations in medical librarianship and information services. Various kinds of health science library and information centers are discussed and biomedical library networks are studied. Students will find it necessary to spend considerable time at the National Library of Medicine or another medical library.

LBSC 624. LEGAL LITERATURE (3)
Survey and evaluation of information sources in law, with emphasis upon the bibliographic organization of the field.

LBSC 626. LITERATURE OF THE FINE ARTS (3)
Consideration and evaluation of the resources of the fine arts, emphasizing bibliography and services contained in fine arts libraries.

LBSC 627. GOVERNMENTAL INFORMATION SYSTEMS (3)
Analysis of the organization of the information structure and the publication and dissemination programs of the U.S. Federal, state and municipal governments.

LBSC 631. BUSINESS INFORMATION SERVICES (3)
Survey and analysis of information sources in business, finance, and economics with emphasis upon their use in problem solving.

LBSC 633. ADVANCED REFERENCE SERVICES (3)
Theoretical and administrative considerations, analysis of research problems, and directed activity in bibliographic method and search techniques in large collections.

LBSC 635. RESOURCES OF AMERICAN LIBRARIES (3)
Considers distribution and extent of library resources, means of surveying collections, mechanisms of inter-institutional cooperation in building collections, and means of developing research collections in special subject fields.

LBSC 636. CHILDREN'S LITERATURE AND MATERIALS (3)
A survey of literature and other media of communication and the criteria in evaluating such materials as they relate to the needs, interests and capability of the child.

LBSC 637. STORYTELLING MATERIALS AND TECHNIQUES (3)
Literary sources are studied and instruction and practice in oral techniques are offered.

LBSC 642. ORGANIZATION OF KNOWLEDGE IN LIBRARIES I (3)
Principles of the organization of library materials for physical and intellectual access. Concepts and problems involved in subject cataloging, classification, and descriptive cataloging. Major systems and rules in use in current practice, particularly those systems popular in the United States.

LBSC 644. ORGANIZATION OF KNOWLEDGE IN LIBRARIES II (3)
Conceptual problems in the organization of knowledge, specific cataloging and classification systems, rules of entry, application of the systems, choice of system to suit particular institutional and patron characteristics.

LBSC 647. SPECIAL PROBLEMS IN THE ORGANIZATION OF KNOWLEDGE (3)
Seminar course in which students may take topics of special interest to them in the area of organization of knowledge and explore them in a research project/class discussion format.

LBSC 650. FUNDAMENTALS OF DOCUMENTATION (3)
The macro-organization of information services in the framework of the overall system of information transfer. The information transfer process is discussed, as well as the fields of study concerned with that process, use and user studies, models of communication and formal and informal communication channels, characteristics and behavior of the literative (bibliometrics), innovations in the communication system.

LBSC 653. CONSTRUCTION AND MAINTENANCE OF INDEX LANGUAGES (3)
Treats the making of classification schedules, subject heading lists and thesauri and those considerations relating to the revision and extension of existing ones.

LBSC 656. INTRODUCTION TO INFORMATION STORAGE AND RETRIEVAL (ISAR) SYSTEMS (3)
Micro-organization of information services and basic principles underlying both manual and mechanized ISAR systems, including the conceptual structure of indexing languages and search strategies, file organization, typology of classifications, abstracting, and indexing.

LBSC 657. TESTING AND EVALUATION OF IR SYSTEMS (3)
A survey of recent developments in the processing, arrangement, and retrieval of the information, and the procedures used in their evaluation.

LBSC 665. PROBLEMS OF SPECIAL MATERIALS (3)
Discusses advanced principles and practices for all technical services, in particular, cataloging applicable to maps, serials, music, audio-visual items. etc.

LBSC 670. SEMINAR IN TECHNICAL SERVICES (3)
Special issues of technical services in large libraries. Deals with such areas as acquisitions, cataloging, serial control, cooperative programs, and managerial controls.

LBSC 674. INTRODUCTION TO REPROGRAPHY (3)
A survey of the processes and technology through which materials are made available in furthering library and information services, ranging from photography to microforms.

LBSC 677. SEMINAR ON MANUSCRIPT COLLECTIONS (3)
Analysis of the methods and philosophy of handling special papers and documentary materials in a research library.

LBSC 700. INTRODUCTION TO DATA PROCESSING FOR LIBRARIES (3)
Basic principles of data processing and the ways in which data processing systems have been applied to library problems. Lectures cover the application of punched card processing to library operations; an introduction to systems analysis and the methodology for establishing systems requirements; and the application of electronic data processing systems to library operations. In the laboratory, the fundamentals of computer programming are provided for developing and running computer programs designed to solve typical library problems.

LBSC 705. ADVANCED DATA PROCESSING IN LIBRARIES (3)
Analysis of retrieval systems and intensive study of machine applications in the acquisition, analysis, coding, retrieval and display of information.

LBSC 711. PROGRAMMING SYSTEMS FOR INFORMATION HANDLING APPLICATIONS (3)
The elements of programming system design and operation are studied with special emphasis on the influence of information handling and library requirements.

LBSC 715. LIBRARY SYSTEMS ANALYSIS (3)
Introduction to the total systems approach to library and information problems, emphasizing administrative and managerial decision-making. Will give a scientific management framework, terms for defining a system, and its problems, and a set of tools, techniques, and methods to aid in analyzing and solving these problems. Topics to be covered include model building, flowcharting, motion and time study, cost analyses, systems design, management information, and cost-effectiveness and planning-programming-budget systems.

LBSC 721. SEMINAR IN INFORMATION SCIENCE (3)
Introduction to the fundamentals in information science. The nature of messages in human and machine communication are approached from the viewpoint of the physical, psychological, and logical transformations which they undergo in their paths from message sender to recipient. Cybernetic variety, basic constraints or variety in information systems, and classes in their uses in search and communications are studied, as well as models, and optimization and mechanization of access of messages for communication of data, information, knowledge.

LBSC 726. SEMINAR IN INFORMATION TRANSFER (3)
Prerequisite, LBSC 721, or permission of instructor. Discussion of significant problems in information science: topics include fundamental concepts, theory, methodology, current research.

LBSC 731. LIBRARY ADMINISTRATION (3)
An introduction to administrative theory and principles and their implications and applications to managerial activity in libraries.

LBSC 736. ADVANCED ORGANIZATION AND ADMINISTRATION OF LIBRARIES AND INFORMATION SERVICES (3)
The student's theoretical understanding of organization and administration will be advanced by intensive study in the various sub-fields of contemporary library and information developments.

LBSC 740. SEMINAR IN LIBRARY AND INFORMATION NETWORK (3)
Explores the inter-library cooperative phenomenon and analyzes critical issues in network planning, economics, organization, technology, and services.

LBSC 743. SEMINAR IN THE ACADEMIC LIBRARY (3)
A seminar on the academic library within the framework of higher education, treating problems of programs, collections, support, planning and physical plant.

LBSC 747. SEMINAR IN THE SPECIAL LIBRARY AND INFORMATION CENTER (3)
A seminar on the development, the uses, the objectives, the philosophy and the particular systems employed in special library service.

LBSC 754. SEMINAR IN THE SCHOOL LIBRARY (3)

LBSC 757. LIBRARY AND INFORMATION SERVICE FACILITIES—OBJECTIVES AND PERFORMANCE (3)
The aim of this course is to describe the context of demands and policies within which an IR or library service facility must operate.

LBSC 804. COMMUNICATION AND LIBRARIES (3)
Theory and research in the multi-discipline domain of communication. Inquiry is directed into such diverse matters as coding theory, linguistic analysis, decision theory, network concepts, etc. Connections are pointed out between communication research and library practice.

LBSC 807. SCIENCE INFORMATION AND THE ORGANIZATION OF SCIENCE (3)

LBSC 815. LIBRARY SYSTEMS (3)
Evolution and current patterns of regional library development, considering the economic, legal, service and management problems associated with library systems as well as the significance of state and Federal programs and national information networks.

LBSC 817. PUBLIC LIBRARY IN THE POLITICAL PROCESS (3)
Seminar on the principal influences which affect the patterns of organization, support and service patterns of public libraries based upon theoretical and case studies.

LBSC 825. LIBRARIES AND INFORMATION SERVICES IN THE SOCIAL PROCESS (3)
The focus is upon the policy process. Key elements in the societal political environment which influence decision-making in libraries and information service facilities are identified and interrelated, such as legislation, citizen participation, organized

groups, mass media, professional associations, technological changes, financial support. The significance of such contemporary issues as censorship, manpower, community control, and automation are considered in this context.

LBSC 827. HISTORY OF LIBRARIES AND THEIR MATERIALS (3)
The development of publication forms and institutions set against the historical framework and the cultural forces within which such advances were made.

LBSC 833. LIBRARY SERVICES TO THE DISADVANTAGED (3)
Approaches, adaptations and potentials of the public library in relation to the problem of poverty. Includes field experience in the school's laboratory library.

LBSC 837. SEMINAR IN INTERNATIONAL AND COMPARATIVE LIBRARIANSHIP AND INFORMATION SCIENCE (3)
Compares and contrasts bibliographical systems, institutions, service arrangements, and professional patterns in developed and developing cultures. Libraries, information organizations and international information systems are viewed against the backdrop of national cultures, and the influence of the social, political and economic factors upon these forms are considered.

LBSC 844. RESEARCH METHODS IN LIBRARY AND INFORMATION ACTIVITY (3)
The techniques and strategies of research and their implications for the definition, investigation and evaluation of library problems.

LBSC 852. SEMINAR IN RESEARCH METHODS AND DATA ANALYSIS (3)

LBSC 855. SEMINAR IN THE ANALYSIS OF THE LIBRARY SERVICE PROCESS (3)
Teams of students, librarians, and library school faculty investigate real problems in libraries on the basis of quantitative data, using analytical skills presented in the first five weeks of the semester.

LBSC 858. SPECIAL TOPICS IN LIBRARY AND INFORMATION SERVICE (3)
No student may earn more than 9 hours under LBSC 858, more than 9 hours under LBSC 859, nor more than a total of 12 hours in both LBSC 858 and LBSC 859.

LBSC 859. INDEPENDENT STUDY (1-3)
Designed to permit intensive individual study, reading or research in an area of specialized interest under faculty supervision, registration is limited to the advanced student who has the approval of his advisors and of the faculty member involved. No student may earn more than 9 hours under LBSC 858, more than 9 hours under LBSC 859, nor more than a total of 12 hours in both LBSC 858 and 859.

LBSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

LINGUISTICS COURSES

LING 401. PHONETICS AND PHONEMICS (3)
Training in the identification, description and symbolization of various sounds found in language. Study of scientific techniques for classifying sounds into units which are perceptually relevant for a given language.

LING 402. MORPHOLOGY AND SYNTAX (3)
A detailed study of language structure. No student may receive credit for both LING 402 and ENGL 484.

LING 403. HISTORICAL LINGUISTICS (3)
Prerequisite, LING 401 and 402, or equivalent. A study of change in the phonological, grammatical and semantic structures of natural languages; language typology; reconstruction and various allied topics will be treated.

LING 609. SEMINAR IN LINGUISTICS (3)
Other programs also offer courses in linguistics that may be of interest to the student. Some of the most relevant are: ANTH 102, CMSC 723, 725, ENGL 484, PHIL 360, PSYC 671, and HESP 604.

MATHEMATICS PROGRAM

Professor and Chairman: Goldhaber
Professors: Adams, Antman, Auslander, Benedetto, Brace, Chu, Cohen Correl, Douglis, Gulick, Edmundson,[1] Ehrlich, Goldberg, Goldstein, Good, Gray, L. Greenberg, Horvath, Hummel, Jackson, Kirwan, Kleppner, Kubota, Lehner, Lipsman, Lopez-Escobar, Maltese, Mikulski, Ortega,[1] Pearl, Reinhart, Rheinboldt,[1] Schaefer, Stellmacher, Strauss, Syski, Vesentini, Zedek
Associate Professors: Alexander, Berg, Bernstein, Cook, Cooper, Dancis, Ellis, Fey,[2] Green, Helzer, Henkelman,[2] Johnson, Lay, Markley, Neri, Osborn, Owings, Sather, Schafer, Schneider, Warner, Wolfe, Yang, Zalcman.
Assistant Professors: Anderson, Currier, Davidson,[2] Fay, Fields, R. Greenberg, Halperin, Harris, Hemperly, Hill, Mucci, Niebur, Powell, Schmidt, Smith, Sweet

[1] joint appointment with Computer Science
[2] joint appoint with Secondary Education

The Department of Mathematics offers strong programs leading to the M.A. and Ph.D. degrees in the fields of Algebra and Number Theory, Complex Analysis, Geometry and Topology, Mathematical Logic, Real and Functional Analysis, Ordinary and Partial Differential Equations, Probability and Statistics, and Applied Mathematics. A student may earn the Master's degree through thesis or non-thesis options. For the M.A. degree, in particular, broad options may be arranged to satisfy different student interests. There are no language requirements for the M.A. degree.

Admission is granted to applicants who demonstrate marked ability and interest in mathematics. While not *required,* results of the Advanced Graduate Record Examination in mathematics are requested if the student has taken the exam.

The Ph.D. degree requires 36 credit hours of coursework. In addition, the student must pass a written qualifying and an oral comprehensive examination.

Translating ability in two foreign languages is also necessary. These requirements are minimal; major emphasis is placed on the preparation of a dissertation representing an original contribution to the existing knowledge of mathematics.

Excellent facilities are available for graduate study and research. These include the Engineering and Physical Sciences Library containing about 79,000 volumes in mathematics, physics, and engineering. The library, conveniently located in the mathematics building, receives approximately 250 journals in pure and applied mathematics. The Library of Congress with its exhaustive collections of books and technical reports is only 30 minutes away from the campus.

The Department of Mathematics cooperates closely with the Institute for Fluid Dynamics and Applied Mathematics. The facilities of the Computer Science Center are also available for the research needs of graduate students and facuity.

MATHEMATICS

MATH 400. VECTORS AND MATRICES (3)
Prerequisite, MATH 141 or 221. Algebra of vector spaces and matrices. Recommended for students interested in the applications of mathematics. (Not open to students who have had MATH 240 or 405)

MATH 401. APPLICATIONS OF LINEAR ALGEBRA (3)
Prerequisite, MATH 240, or 400, or consent of the instructor. Various applications of linear algebra: theory of finite games, linear programming, matrix methods as applied to finite Markov chains, random walk, incidence matrices, graphs and directed graphs, networks, transportation problems.

MATH 402. ALGEBRAIC STRUCTURES (3)
Prerequisite, MATH 240 or equivalent. The course is designed for students having only limited experience with rigorous mathematical proofs, and parallels MATH 403. Students planning graduate work in mathematics should take MATH 403. Groups, rings, integral domains and fields; detailed study of several groups; properties of integers and polynomials. Emphasis is on the origin of the mathematical ideas studied and the logical structure of the subject. (Not open to mathematics graduate students.)

MATH 403. INTRODUCTION TO ABSTRACT ALGEBRA (3)
Prerequisite, MATH 241 or equivalent. Integers; groups, rings, integral domains, fields.

MATH 404. FIELD THEORY (3)
Prerequisite, MATH 403. Algebraic and transcendental elements, Galois theory, constructions with straight-edge and compass, solutions of equations of low degrees, insolubility of the quintic, Sylow theorems, fundamental theorem of finite abelian groups.

MATH 405. INTRODUCTION TO LINEAR ALGEBRA (3)
Prerequisite, MATH 403 or consent of instructor. An abstract treatment of finite dimensional vector spaces. Linear transformations and their invariants.

MATH 406. INTRODUCTION TO NUMBER THEORY (3)
Prerequisite, one year of college mathematics. Rational integers, divisibility, prime numbers, modules and linear forms, unique factorization theorem, Euler's function, Mobius' function, cyclotomic polynomial, congruences and quadratic residues, Legendre's and Jacobi's symbol, reciprocity law of quadratic residues, introductory explanation of the method of algebraic number theory.

MATH 410. ADVANCED CALCULUS (3)
Prerequisite, MATH 241. First semester of a year's course. Subjects covered during the year are: sequences and series of numbers, continuity and differentiability of real valued functions of one variable, the Riemann integral, sequences of functions, and power series. Functions of several variables including partial derivatives, multiple integrals, line and surface integrals. The implicit function theorem.

MATH 411. ADVANCED CALCULUS (3)
Prerequisite, Math 410, and Math 240 or Math 400. Continuation of Math 410.

MATH 413. INTRODUCTION TO COMPLEX VARIABLES (3)
Prerequisite, MATH 410. The algebra of complex numbers, analytic functions, mapping properties of the elementary functions. Cauchy's theorem and the Cauchy integral formula. Residues. (Credit will be given for only one of the courses, MATH 413 or 463).

MATH 414. DIFFERENTIAL EQUATIONS (3)
Prerequisite, Math 410, and Math 240 or equivalent. Existence and uniqueness theorems for initial value problems. Linear theory: fundamental matrix solutions, variation of constants formula, Floquet theory for periodic linear systems. Asymptotic orbital and Lyapunov stability with phase plane diagrams. Boundary value theory and series solutions are optional topics.

MATH 415. INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS (3)
Prerequisites, MATH 410 or 462. Topics will include one dimensional wave equation; linear second order equations in two variables, separations of variables and Fourier series; Sturm-Liouville theory.

MATH 416. INTRODUCTION TO REAL VARIABLES (3)
Prerequisite· MATH 410. The Lebesque integral. Fubini's theorem. The L^p spaces.

MATH 417. INTRODUCTION TO FOURIER ANALYSIS (3)
Prerequisite, MATH 410. Fourier series. Fourier and Laplace transforms.

MATH 430. GEOMETRIC TRANSFORMATIONS (3)
Prerequisite, MATH 240. Recommended for students in mathematics education. Important groups of geometric transformations, including the isometries and similarities of the plane. Geometries related to transformation groups.

MATH 431. FOUNDATIONS OF GEOMETRY (3)
Prerequisite, one year of college mathematics. Recommended for students in mathematics education. The axiomatic foundations of geometry. Attention will be given to one or more axiomatic develop-

ments of Euclidean geometry and to the relation of Euclidean geometry to other geometric systems.

MATH 432. INTRODUCTION TO POINT SET TOPOLOGY (3)
Prerequisite, MATH 410 or 450, or equivalent. Connectedness, compactness, transformations, homomorphisms; application of these concepts to various spaces, with particular attention to the Euclidean plane.

MATH 433. INTRODUCTION TO ALGEBRAIC TOPOLOGY (3)
Prerequisite, MATH 403 and 432, or equivalent. Chains, cycles, homology groups for surfaces, the fundamental group.

MATH 436. INTRODUCTION TO DIFFERENTIAL GEOMETRY (3)
Prerequisite, MATH 241 or equivalent. The differential geometry of curves and surfaces, curvature and torsion, moving frames, the fundamental differential forms, intrinsic geometry of a surface.

MATH 444. ELEMENTARY LOGIC AND ALGORITHMS (3)
Prerequisite, MATH 240 or consent of instructor. An elementary development of propositional logic, predicate logic, set algebra, and Boolean algebra, with a discussion of Markov algorithms, Turing machines and recursive functions. Topics include Post productions, word problems, and formal languages. (Also listed as CMSC 450.)

MATH 446. AXIOMATIC SET THEORY (3)
Prerequisite, MATH 403 or 450 or consent of instructor. Development of a system of axiomatic set theory, choice principles, induction principles, ordinal arithmetic including discussion of cancellation laws, divisibility, canonical expansions, cardinal arithmetic including connections with the axiom of choice, Hartog's theorem, König's theorem, properties of regular, singular, and inaccessible cardinals.

MATH 447. INTRODUCTION TO MATHEMATICAL LOGIC (3)
Prerequisite, MATH 403 or 410 or 450. Formal propositional logic, completeness, independence, decidability of the system, formal quantificational logic, first-order axiomatic theories, extended Gödel completeness theorem, Lowenheim-Skolem theorem, model-theoretical applications.

MATH 450. FUNDAMENTAL CONCEPTS OF MATHEMATICS (3)
Prerequisite, MATH 240 or consent of instructor. Sets, relations, mappings. Construction of the real number system starting with Peano postulates; algebraic structures associated with the construction; Archimedean order, sequential completeness and equivalent properties of ordered fields. Finite and infinite sets, denumerable and non-denumerable sets.

MATH 460. COMPUTATIONAL METHODS (3)
Prerequisite, MATH 241, and CMSC 110 or elementary knowledge of computer programming or equivalent. Introduction to the analysis of numerical methods for solving linear systems of equations, nonlinear equations in one variable, interpolation and approximation problems and the solution of initial value problems for ordinary differential equations. Emphasis on the theoretical foundations. Intended primarily for students in Mathematics, Applied Mathematics, and Computer Science. Not open to students who have passed MATH/CMSC 460. (Listed also as CMSC 470.)

MATH 462. ANALYSIS FOR SCIENTISTS AND ENGINEERS I (3)
Prerequisite, Math 240 or consent of instructor. Not open to students with credit for Math 241. Calculus of functions of several real variables; limits, continuity, partial differentation, multiple integrals, line and surface integrals, vector-valued functions, theorems of Green, Gauss and Stokes, physical applications. (This course cannot be counted toward a major in mathematics.)

MATH 463. COMPLEX VARIABLES FOR SCIENTISTS AND ENGINEERS (3)
Prerequisite, Math 241 or equivalent. The algebra of complex numbers, analytic functions, mapping properties of the elementary functions. Cauchy integral formula. Theory of residues and application to evaluation of integrals. Conformal mapping. (Credit will be given for only one of the courses—Math 413 or Math 463.)

MATH 464. INTRODUCTION TO THE METHODS OF MATHEMATICAL PHYSICS (3)
Prerequisite, Math 463 or 413, and Math 246 or equivalent. Fourier series, Fourier and Laplace transforms. Evaluation of the complex version integral by the theory of residues. Applications to ordinary and partial differential equations of mathematical physics; solutions using transforms and separation of variables. Additional topics such as Bessel Functions and calculus of variations may be included.

MATH 470. INTRODUCTION TO NUMERICAL ANALYSIS (3)
Prerequisite, MATH 241. Introduction to the analysis of numerical methods for solving linear systems of equations, nonlinear equations in one variable, interpolation and approximation problems and the solution of initial value problems for ordinary differential equations. Stress is placed on providing the student with a good understanding of the theoretical foundations of the various methods. Intended primarily for students in mathematics, applied mathematics, and computer science. This course should not be taken by students who have passed MATH/CMSC 460. (Listed also as CMSC 470.)

MATH 472. DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS (3)
Prerequisites: CMSC 110, and Math 410, and Math 405 or Math 474. A general introduction to the theory of ordinary differential equations emphasizing numerical methods for constructing approximate solutions. Topics included are existence and uniqueness theorems, Runge-Kutta method, systems of linear differential equations, phase plane methods, and numerical solution of boundary value problems.

MATH 474. APPLIED LINEAR ALGEBRA (3)
Prerequisite: Math 240 and Math 241, or equivalent. A treatment of finite dimensional linear spaces and linear transformations with an emphasis on applications and computational aspects.

MATH 475. COMBINATORICS AND GRAPH THEORY (3)
Prerequisite: Math 240 or equivalent. General enumeration methods, difference equations, generating functions. Elements of graph theory to transport networks, matching theory and graphical algorithms. (Listed also as CMSC 475.)

MATH/STAT/CMSC 477. OPTIMIZATION (3)
Prerequisite: CMSC 110 and Math 405 or Math 474. Linear programming including the simplex algorithm and dual linear programs, convex sets and elements of convex programming, combinatorial optimization, integer programming. (Listed also as Stat 477 and CMSC 477.)

MATH 478. SELECTED TOPICS FOR TEACHERS OF MATHEMATICS (1-3)
Prerequisite, one year of college mathematics or consent of instructor.

MATH 481. INTRODUCTION TO NUMBER THEORY (3)
Prerequisite, one year of college mathematics or consent of instructor. Elementary number theory and the development of the real numbers for teachers. (Not open to students majoring in mathematics or physical sciences.)

MATH 482. INTRODUCTION TO ALGEBRA (3)
Prerequisite, one year of college mathematics or consent of instructor. Modern ideas in algebra and the theory of equations for teachers. (Not open to students majoring in mathematics or physical sciences.)

MATH 483. INTRODUCTION TO GEOMETRY (3)
Prerequisite, one year of college mathematics or consent of instructor. A study of basic ideas from Euclidean and non-Euclidean geometry for teachers. (Not open to students majoring in mathematics or physical sciences.)

MATH 484. INTRODUCTION TO ANALYSIS (3)
Prerequisite, one year of college mathematics or consent of instructor. A study of the limit concept and the calculus for teachers. Previous knowledge of calculus is not required. (Not open to students majoring in mathematics or physical sciences.)

MATH 488. NATIONAL SCIENCE FOUNDATION SUMMER INSTITUTE FOR TEACHERS OF SCIENCE AND MATHEMATICS. SEMINAR (1-3)
Lectures and discussion to deepen the students appreciation of mathematics as a logical discipline and as a medium of expression. Special emphasis on topics relevant to current mathematical curriculum studies and revisions.

MATH 498. SELECTED TOPICS IN MATHEMATICS (VARIABLE CREDIT)
Prerequisite, permission of the instructor. Topics of special interest to advanced undergraduate students will be offered occasionally under the general guidance of the Departmental Committee on Undergraduate Studies. Honors students register for reading courses under this number.

MATH 600. ABSTRACT ALGEBRA I (3)
Prerequisite, MATH 405 or equivalent. Groups with operators, homomorphism and isomorphism theorems, normal series, Sylow theorems, free groups, Abelian groups, rings, integral domains, fields, modules. If time permits, Hom (A,B), tensor products, exterior algebra.

MATH 601. ABSTRACT ALGEBRA II (3)
Prerequisite, MATH 600 or consent of instructor. Field theory, Galois theory, multilinear algebra. Further topics from: Dedekind domains, Noetherian domains, rings with minimum conditions, homological algebra.

MATH 602. HOMOLOGICAL ALGEBRA (3)
Prerequisite, MATH 600. Projective and injective modules, homological dimensions, derived functions, spectral sequence of a composite functor. Applications.

MATH 603. COMMUTATIVE ALGEBRA (3)
Prerequisite, MATH 600. Ideal theory of Noetherian rings, valuations, localizations, complete local rings, Dedekind domains.

MATH 604. RING THEORY (3)
Prerequisite, MATH 601 or consent of instructor. Topics selected from the following: Ideal theory, structure theory of rings with or without minimum condition, division rings, algebras, non-associative rings.

MATH 605. GROUP THEORY (3)
Prerequisite, MATH 601 or consent of instructor. Topics selected from the following: finite groups, abelian groups, free groups, solvable or nilpotent groups, groups with operators, groups with local properties, groups with clan conditions, extensions.

MATH 606. ALGEBRAIC GEOMETRY I (3)
Prerequisite, MATH 600 and MATH 601 or consent of instructor. Prime and primary ideals in Noetherian rings, Hilbert Nullstellensatz places and valuations, prevarieties (in the sense of Serre), dimension, morphisms, singularities, varieties, schemes, rationality.

MATH 607. ALGEBRAIC GEOMETRY II (3)
Prerequisite, MATH 606. Topics in contemporary algebraic geometry chosen from among; theory of algebraic curves and surfaces, elliptic curves, abelian varieties, theory of schemes, theory of zeta functions, formal cohomology, algebraic groups, reduction theory.

MATH 608. SELECTED TOPICS IN ALGEBRA (3)
Prerequisite, consent of instructor.

MATH 620. ALGEBRAIC NUMBER THEORY I (3)
Prerequisites, MATH 601 or consent of instructor. Algebraic numbers and algebraic integers, algebraic number fields of finite degree, ideals and units, fundamental theorems of algebraic number theory, theory of residue classes; Minkowski's theorem on linear forms, class numbers, Dirichlet's theorem on units, relative algebraic number fields, decomposi-

tion group, inertia group and ramification group of prime ideals with respect to a relatively Galois extension.

MATH 621. ALGEBRAIC NUMBER THEORY II (3)
Prerequisites, MATH 600, 620 or equivalent. Valuation of a field, algebraic function fields, completion of a valuation field, ramification exponent and residue class degree, ramification theory, elements, differents, discriminants, product formula and characterization of fields by the formula, Gauss sum, class number formula of cyclotomic fields.

MATH 630. REAL ANALYSIS I (3)
Prerequisite, MATH 410 or equivalent. Lebesgue measure and integration on the line. Differentiation, absolute continuity, L^p spaces, Fubini's theorem. If time permits, some applications to Fourier series and transforms.

MATH 631. REAL ANALYSIS II (3)
Prerequisite, MATH 630. Set functions and integration in general measure spaces, Lebesgue spaces, representation of bounded linear functionals on L^p, spaces of measures, Radon-Nikodym theorem, product measure spaces (Fubini and Tonelli theorems), differentiation of set functions, Riesz representation theorem. Selected topics; e.g., harmonic analysis, vector-valued measure, product measure of infinitely many measure spaces.

MATH 632. FUNCTIONAL ANALYSIS I (3)
Prerequisites, MATH 631, 660. Theory of linear spaces and linear operators, including spectral analysis and the concepts of duality and convexity. Applications to differential equations and distribution theory.

MATH 633. FUNCTIONAL ANALYSIS II (3)
Prerequisites, MATH 631, 660. Introduction to abstract harmonic analysis, including Banach algebra, Fourier analysis, group representations and transformation groups. NOTE: 633 and 632 are independent courses, intended to introduce students to two distinct but related areas of functional analysis.

MATH 634. LINEAR SPACES I (3)
Prerequisite, MATH 632. Linear topological spaces, locally convex spaces, inductive limits, duality theory, Baire spaces, barreled spaces, uniform boundedness principle, closed graph and open mapping theorems on Frechet spaces, distributions.

MATH 635. LINEAR SPACES II (3)
Prerequisite, MATH 634. Topological tensor products, nuclear spaces and mappings, general closed graph theorems.

MATH 636. BANACH ALGEBRAS (3)
Prerequisite, MATH 632. The Gelfand representation; involution algebras, commutative and noncommutative representation theorems of Gelfand-Neumark; applications to spectral theory and abstract harmonic analysis.

MATH 640. TOPOLOGICAL GROUPS I (3)
Prerequisite, MATH 630 and 631 or 730, or consent of instructor. General nature of topological groups including homomorphism theorems, Haar measure, representations of compact groups and the Peter-Weyl theorem, Pontrjagin duality, Tanaka duality and the Plancherel theorem.

MATH 641. TOPOLOGICAL GROUPS II (3)
Prerequisite, MATH 640, or equivalent. The concept of Lie groups, the structure of compact groups, relations between Lie groups and Lie algebras, the structure of compact Lie groups. Transformation groups.

MATH 648. SELECTED TOPICS IN ANALYSIS (3)
Prerequisite, consent of instructor.

MATH 654. NON-LINEAR ELASTICITY (3)
Prerequisite, MATH 690. Fundamentals of non-linear elasticity. Finite deformations, rubber elasticity, small deformations superimposed on finite deformations.

MATH 660. COMPLEX ANALYSIS I (3)
Prerequisite, MATH 410 or equivalent. Linear transformations, analytic functions, conformal mappings, Cauchy's theorem and applications, power series, partial fractions and factorization, elementary Riemann surfaces, Riemann's mapping theorem.

MATH 661. COMPLEX ANALYSIS II (3)
Prerequisites, MATH 630, 660. Topics in conformal mappings, normal families, Picard's theorem, classes of univalent functions, extremal properties, variational methods, elliptic functions, Riemann surfaces.

MATH 664. INTERPOLATION AND APPROXIMATION —(COMPLEX DOMAIN) (3)
Prerequisite, MATH 660 or consent of instructor. Possibility of approximation by polynomials, lemniscates. Interpolation by polynomials. Maximal convergence. Uniform distribution of points. Interpolation and approximation by rational functions. Rational functions with some free poles.

MATH 665. INTERPOLATION AND APPROXIMATION —(REAL FUNCTIONS) (3)
Interpolation of real functions and remainder theory. Uniform and least square approximations, Chebychev oscillation theorems. Orthogonal polynomials. Degree of approximation. Abstract formulation of approximation theory. Constructive function theory.

MATH 666. SPECIAL FUNCTIONS (3)
Prerequisite, MATH 660 or consent of instructor. Gamma function, Riemann zeta-function, hypergeometric functions, confluent hypergeometric functions, Bessel functions.

MATH 668. SELECTED TOPICS IN COMPLEX ANALYSIS (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. Typical courses: Riemann, surfaces, automorphic functions, several complex variables, symmetric spaces.

MATH 670. ORDINARY DIFFERENTIAL EQUATIONS I (3)
Prerequisite, MATH 405 and 410 or the equivalent. Existence and uniqueness, linear systems usually with Floquet theory for periodic systems, linearization and stability, planar systems usually with Poincare-Bendixson theorem. Extra topics may be covered.

MATH 671. ORDINARY DIFFERENTIAL EQUATIONS II (3)
Prerequisites, MATH 630 and 670 or the equivalent. The content of this course varies with the interests of the instructor and the class. Stability theory, control, time delay systems, Hamiltonian systems, bifurcation theory, and boundary value problems and the like.

MATH 673. PARTIAL DIFFERENTIAL EQUATIONS I (3)
Prerequisite, MATH 411 or consent of instructor. Gauss and Green formulas, the Cauchy problem for the wave equation method of descent and Huygens principle. The Dirichlet and Neumann problem for the Laplace equation, single and double layer potentials, Green's functions, the method of integral equations.

MATH 674. PARTIAL DIFFERENTIAL EQUATIONS II (3)
Prerequisite, MATH 673. Introduction to modern theories in partial differential equations. Topics include: existence and uniqueness questions, concepts of weak and strong solutions, applications of functional analysis.

MATH 676. NUMERICAL METHODS IN ORDINARY DIFFERENTIAL EQUATIONS (3)
Prerequisites, MATH 405 and 414. Discrete variable methods for solving initial value and boundary value problems in ordinary differential equations. Stability theory.

MATH 677. NUMERICAL METHODS IN PARTIAL DIFFERENTIAL EQUATIONS (3)
Prerequisites, MATH 405 and 673. Approximation methods for boundary value, initial value, and eigenvalue problems in partial differential equations, including finite differences and methods involving approximating functions.

MATH 680. EIGENVALUE AND BOUNDARY VALUE PROBLEMS I (3)
Prerequisites, MATH 405 and 410. Linear analysis and applications to modern applied mathematics. The central theme of the course will be the theory of compact operators on Hilbert space and its applications to integral equations and eigenvalue and boundary value problems for ordinary differential equations.

MATH 681. EIGENVALUE AND BOUNDARY VALUE PROBLEMS II (3)
Prerequisite, MATH 680. Asymptotic behavior of eigenvalues and eigenfunctions for second-order ordinary and partial differential equations. Variational formulation of boundary value problems. Upper and lower bounds for eigenvalues. isoperimetric inequalities.

MATH 682. VARIATIONAL METHODS (3)
Prerequisite, consent of instructor. The Euler-Lagrange equation, minimal principles in mathematical physics, estimation of capacity, torsional rigidity and other physical quantities; symmetrization, isoperimetric inequalities, estimation of eigenvalues, the minimax principle.

MATH 683. NUMERICAL ANALYSIS (3)
Prerequisite, MATH/CMSC 460 or 470, MATH 405, and 410. Perturbation theorems for linear equations and eigenvalue problems. Stability of solutions of ordinary differential equations. Discretization errors for ordinary differential equations. Rounding error for linear equations. Convergence theorems for iterative methods for linear and nonlinear equations. (Also listed as CMSC 670).

MATH 684. ALGORITHMIC NUMERICAL ANALYSIS (3)
Prerequisites, MATH/CMSC 460 or 470, and CMSC 110. Detailed study of problems arising in the implementation of numerical algorithms on a computer. Typical problems include rounding errors, their estimation and control; numerical stability considerations; stopping criteria for converging processes; parallel methods. Examples from linear algebra, differential equations, minimization. (Also listed as CMSC 770.)

MATH 690. INTRODUCTION TO CONTINUUM MECHANICS (3)
Prerequisite, consent of instructor. Solid and fluid continua, general analysis of stress and strain, equilibrium of elastic bodies, equations of motion for fluid bodies, stress-strain relations, equations of perfect fluids and formulation of viscous flow problems.

MATH 692. FLUID DYNAMICS I (3)
Prerequisite, consent of instructor. A mathematical formulation and treatment of problems arising in the theory of incompressible, compressible and viscous fluids.

MATH 693. FLUID DYNAMICS II (3)
Prerequisite, consent of instructor. A continuation of the topics studied in Fluid Dynamics I.

MATH 694. ADVANCED LINEAR NUMERICAL ANALYSIS (3)
Prerequisite, MATH/CMSC 470. Methods for the solution of linear systems of equations; in particular, iterative methods and their convergence theory. The numerical solution of the algebraic eigenvalue problem. (Also listed as CMSC 770.)

MATH 695. LINEAR ELASTICITY (3)
Prerequisite, MATH 690. Linear elastic behavior of solid continuous media. Topics covered include torsion and flexure of beams, plane strain and plane stress, vibration and buckling problems, variational principles. Emphasis is placed on formulation and technique rather than on specific examples.

MATH 696. ADVANCED NONLINEAR NUMERICAL ANALYSIS (3)
Prerequisites, MATH/CMSC 670 and MATH 441. Iterative solution of nonlinear operator equations; in particular, nonlinear systems of equations. Existence questions. Minimization methods and applications to approximation problems. (Also listed as CMSC 772.)

MATH 697. ADVANCED MATHEMATICAL PROGRAMMING (3)
Prerequisites, STAT 411 and 470 or consent of instructor. Non-linear programming methods. Dynamic

programming problems as they arise in Markov chain optimizations. Sequential analysis, search models, and inventory theory. Recent concepts and methods in discrete optimization problems.

MATH 698. SELECTED TOPICS IN APPLIED MATHEMATICS (3)
Prerequisite, consent of instructor.

MATH 699. PROSEMINAR IN RESEARCH (1)
Prerequisite, one semester of graduate work in mathematics.

MATH 700. ADVANCED CLASSICAL ANALYSIS I (3)
Prerequisite, MATH 413. A basic course in those parts of analysis essential for applied mathematics. Topics covered: asymptotic analysis and special functions of mathematical physics.

MATH 701. ADVANCED CLASSICAL ANALYSIS II (3)
Prerequisite, MATH 413. Further study in analysis essential for applied mathematics. Topics covered include Fourier series and integrals, and integral transforms.

MATH 710. CONSISTENCY PROOFS IN SET THEORY (3)
Prerequisites, MATH 446 and 447. Consistency and independence of such fundamental principles of set theory as the laws of choice, of cardinal arithmetic of constructibility and regularity. Gödel's model of constructible sets, inner models, Cohen's generic models.

MATH 712. MATHEMATICAL LOGIC I (3)
Prerequisite, MATH 447. The fundamentals for the theory of models, completeness and incompleteness in formal theories, decidable theories, undecidable theories. Topics include model-theoretical applications of the compactness theorem for formal languages, definability theorems, Lowenheim-Skolem theorems. Gödel's incompleteness theorem, elimination-of-quantifier methods in decidable theories, the undecidability theorems of Church and Tarski.

MATH 713. MATHEMATICAL LOGIC II (3)
Prerequisite, MATH 447. Recursion theory and proof theory. Topics include enumeration and normal form theorems, the classification of recursively enumerable sets, degrees of unsolvability, the arithmetical hierarchy, consistency proofs within arithmetic, Gödel's theorem on the unprovability of the consistency of certain theories within arithmetic, a consistency proof for Peano arithmetic.

MATH 715. MODEL THEORY (3)
Prerequisite, MATH 712. Topics to be covered include the compactness theorem and Lowenheim-Skolem theorems for first-order logic. "Omega" completeness theorems, ultra products, saturated and special models, definability results, categoricity in power, omitting types of elements, and applications to algebra and analysis.

MATH 716. RECURSIVE FUNCTION THEORY (3)
Prerequisite, MATH 713. Topics to be covered are formal definitions of computability and recursive functions, Kleenes' enumeration and fixed-point theorems. Turing reducibility, the arithmetical hierarchy. Other topics are simple and hypersimple sets, truth-table reducibility, creative sets, Myhill's theorem in one-one reducibility, deficiency sets, Friedberg's solution of Post's problem, maximal sets, retraceable sets, major subsets, the analytical hierarchy, recursive ordinals, hyper arithmetical sets.

MATH 718. SELECTED TOPICS IN MATHEMATICAL LOGIC (3)
Prerequisite, consent of instructor.

MATH 730. TOPOLOGY I (3)
Prerequisite, MATH 410. Topological spaces, continuous maps, homeomorphisms. Product and quotient spaces. Existence of real-valued functions. Metric and metrizable spaces.

MATH 731. TOPOLOGY II (3)
Prerequisite, MATH 730, some familiarty with abstract algebra. Spaces of mappings, fundamental group, covering spaces. Finite simplicial complexes and simplicial mappings. Simplicial homology, theory. Fixed point theorems.

MATH 734. ALGEBRAIC TOPOLOGY I (3)
Prerequisite, MATH 731. Singular homology, uniqueness theorems, tensor products and homomorphisms, the functors ext and tor. Universal coefficient theorems, Künneth and Eilenberg-Zilber, products and duality.

MATH 735. ALGEBRAIC TOPOLOGY II (3)
Prerequisite, MATH 734. Higher homotopy groups, CW complexes, obstruction theory, Eilenberg-Mac-Lane spaces, the Serre spectral sequences.

MATH 737. POINT SET TOPOLOGY (3)
Prerequisite, MATH 730. Characterization of paths, arcs, and the cantor set. Polyhedral Jordan curve and Schoenfliess theorems. Retracts and neighborhood retracts. Fixed point theorems. Dimension theory. General position theorems for mappings of polyhedra and metric spaces, with applications.

MATH 740. DIFFERENTIAL GEOMETRY (3)
Prerequisite, MATH 746 or consent of instructor. Connections, curvature, torsion, symplectic contact, and complex structures.

MATH 742. DIFFERENTIAL TOPOLOGY (3)
Prerequisite, MATH 746. Characteristic classes, cobordism, differential structures on cells and spheres.

MATH 744. LIE GROUPS I (3)
Prerequisites, MATH 403, 405, 411, and 432, their equivalents, or consent of instructor. An introduction to the fundamentals of Lie groups, including some material on groups of matrices and Lie algebras.

MATH 745. LIE GROUPS II (3)
Prerequisite, MATH 744, or consent of instructor. A continuation of Lie Groups I in which some of the following topics will be emphasized: solvable Lie groups, compact Lie groups, classifications of semi-simple Lie groups, representation theory, homogeneous spaces.

MATH 746. DIFFERENTIABLE MANIFOLDS (3)
Prerequisite, consent of instructor. Differentiable manifolds, embeddings in Euclidean space, vector and tensor bundles, vector fields, differentiable fields. Riemann metrics.

MATH 748. SELECTED TOPICS IN GEOMETRY AND TOPOLOGY (3)
Prerequisite, consent of instructor.

MATH 799. MASTER'S THESIS RESEARCH (1-6)
MATH 899. DOCTORAL DISSERTATION RESEARCH (1-8)

STATISTICS AND PROBABILITY

STAT 400. APPLIED PROBABILITY AND STATISTICS I (3)
Prerequisite, MATH 141 or MATH 221. Random variable, common distributions, moments, law of large numbers and central limit theorem. Sampling methods, estimation of parameters, testing of hypotheses, analysis of variance, regression and correlation.

STAT 401. APPLIED PROBABILITY AND STATISTICS II (3)
Prerequisites, STAT 400 (MATH 241 recommended). Point estimation, sufficient unbiased, and consistent estimators. Minimum variance and maximum likelihood estimators. Interval estimation. Testing of hypotheses. Regression and linear hypotheses. Sampling distributions. Experimental designs. Sequential tests, elements of nonparametric methods.

STAT 410. INTRODUCTION TO PROBABILITY THEORY (3)
Prerequisite, MATH 241. Probability and its properties. Random variables and distribution functions in one and several dimensions. Moments. Characteristic functions. Limit theorems.

STAT 411. INTRODUCTION TO STOCHASTIC PROCESSES (3)
Prerequisite, STAT 410, or MATH 410 and one of STAT 250 or STAT 400. Elementary stochastic processes. Renewal process, random walks, branching process, discrete Markov chains, first passage times. Markov chains with a continuous parameter, birth and death processes. Stationary processes and their special properties.

STAT 420. INTRODUCTION TO STATISTICS I (3)
Prerequisite, STAT 410 or STAT 400 and MATH 410. Short review of probability concepts including sampling distributions. Interval estimation. Theory of order statistics. Tolerance limits. Limit distributions and stochastic convergence. Sufficient statistics. Completeness and stochastic independence. Rao-Blackwell theorem.

STAT 421. INTRODUCTION TO STATISTICS II (3)
Prerequisite, STAT 420 or STAT 401 and MATH 410. Loss and risk functions. Statistical decisions. Optimality criteria. Uniformly minimum risk procedures. Bayesian risk, minimax principle. Point estimation theory. Statistical hypotheses and optimal tests. Likelihood ratio tests. Elements of linear hypotheses, analysis of variance and sequential theory.

STAT 450. REGRESSION AND VARIANCE ANALYSIS (3)
Prerequisite, STAT 401 or 420. One, two, three and four-way layouts in analysis of variance, fixed effects models, linear regression in several variables, Gauss-Markov theorem, multiple regression analysis, experimental designs.

STAT 464. INTRODUCTION TO BIOSTATISTICS (3)
Prerequisite, one semester of calculus and junior standing. Probabilistic models. Sampling. Some applications of probability in genetics. Experimental designs. Estimation of effects of treatment. Comparative experiments. Fisher-Irwin test. Wilcoxon tests for paired comparisons.

STAT 477. OPTIMIZATION. (3)
Prerequisite: CSMC 110 and MATH 405 or MATH 474. Linear programming including the simplex algorithm and dual linear programs, convex sets and elements of convex programming, combinatorial optimization, integer programming. (Listed also as Math 477 and CMSC 477.)

STAT 600. PROBABILITY THEORY I (3)
Prerequisite, STAT 410 or MATH 410 with one semester of Probability. Probability space, classes of events, construction of probability measures, Random variables, convergence theorems, images of measures. Independence. Expectation and moments, Lebesgue integration, L^p spaces, Radon-Nikodym theorem, singular and absolutely continuous measures. Conditional expectations, existence of regular distributions; applications. Probabilities on product spaces, Fubini theorem, Kolmogorov extension theorem, Tulcea product theorem.

STAT 601. PROBABILITY THEORY II (3)
Prerequisite, STAT 600, MATH 413 recommended. Characteristic functions of distribution functions. Bochner's representation theorem. Helly's theorems and Levy's inversion formula. Application of Cauchy's residue theorem. Infinitely divisible distributions. Kolmogorov's three-series theorem. Law of the iterated logarithm. Arc sine law. Central limit theorems for independent and dependent random variable Lindeberg-Feller theorem. Weak and strong laws of large numbers. Martingale convergence theorems (for sequences).

STAT 610. STOCHASTIC PROCESSES I (3)
Prerequisite, STAT 601. Separability, measurability, and simple continuity of stochastic processes. Stopping times. Martingales; fundamental inequalities, convergence theorems and their applications, continuity theorems, martingale times, sample function behavior. Processes with independent (orthogonal) increments, Brownian motion. Stationary processes, spectral analysis and ergodic theory.

STAT 611. STOCHASTIC PROCESSES II (3)
Prerequisite, STAT 601. Definition and classification of Markov processes. Properties of transition probabilities, forward and backward equations (boundary conditions), absorption probabilities, strong Markov-property. Markovian semigroups, extended infinitesimal operator. Sample function behavior. Connections between semigroups approach and sample function approach. Diffusion theory, Ito equation. Potential theory.

STAT 650. APPLIED STOCHASTIC PROCESSES (3)
Prerequisite, STAT 410 or MATH 410 with one semester of Probability. Basic concepts of stochastic processes. Renewal processes and random walks, fluctuation theory. Stationary processes, spectral analysis. Markov chains and processes (discrete and continuous parameters). Birth and death pro-

cesses, diffusion processes. Applications from theories of queueing, storage. Inventory, epidemics, noise, prediction and others.

STAT 698. SELECTED TOPICS IN PROBABILITY (3)
Prerequisite, consent of instructor.

STAT 700. MATHEMATICAL STATISTICS I (3)
Prerequisite, STAT 410 or STAT 401 and MATH 410, or equivalent. Special distributions, expectations, moments, characteristic functions. Multivariate distributions, sampling distributions, limit theorems. Transformations, order statistics, series representations. Estimation, Cramer-Rao inequality, maximum likelihood. Gauss-Markov theorem, and Bayes estimates.

STAT 701. MATHEMATICAL STATISTICS II (3)
Prerequisite, STAT 700 or STAT 420. Tests of hypotheses, Neyman-Pearson lemma, and likelihood ratio tests. Bayesian inference. Goodness-of-fit and contingency tables. Regression and analysis of variance. Non-parametric tests, sequential analysis, multivariate analysis.

STAT 710. ADVANCED STATISTICS I (3)
Prerequisite, STAT 421. Concurrent registration with STAT 600 recommended. Statistical decision theory. Neyman-Pearson lemma and its extensions. Uniformly most powerful test. Monotone likelihood ratio. Exponential families of distributions, concepts of similarity, and tests with Neyman structure. Unbiased tests and applications to normal families.

STAT 711. ADVANCED STATISTICS II (3)
Prerequisite, STAT 710. Invariance, almost invariance, and applications to analysis of variance and regression. Elements of asymptotic theory. Minimax principle and Hunt-Stein theorem.

STAT 720. NONPARAMETRIC STATISTICS (3)
Prerequisite, STAT 710. Order statistics. Nonparametric point and set estimation. Stochastic approximation. Tolerance regions. Invariance principle and its applications. Large sample properties and optimality criteria, efficacy, Pitman efficiency. Rank tests and Kolmogorov-Smirnov type tests. U-statistics.

STAT 750. MULTIVARIATE ANALYSIS (3)
Prerequisite, STAT 420 and MATH 400, or STAT 700. Multivariate normal, Wishart's and Hotelling's distributions. Tests of hypotheses, estimation. Generalized distance, discriminant analysis. Regression and correlation. Multivariate analysis of variance; distribution of test criteria.

STAT 760. SAMPLING THEORY (3)
Prerequisite, STAT 420 or STAT 700. Simple random sampling. Sampling for proportions. Estimation of sample size. Sampling with varying probabilities of sampling. Sampling: stratified, systematic, cluster, double, sequential, incompleted.

STAT 798. SELECTED TOPICS IN STATISTICS (3)
Prerequisite, consent of instructor.

APPLIED MATHEMATICS PROGRAM

Professors: Almon (ECON), Antman (MATH), Aziz (MATH—UMBC), Babuska (IFDAM), Bhatia (MATH—UMBC), Banerjee (PHYS), Brill (PHYS), Cadman (CHE), Campolattaro (PHYS—UMBC), Cunniff (ME), Davidson (PHYS), DeClaris (EE, IFDAM), Dorfman (IFDAM), Douglis (MATH), Edmundson (CSC), Greenberg (PHYS), Gross (MATH—UMBC), Hubbard (IFDAM), Jones (IFDAM), Kanal (CSC), Karlovitz (IFDAM), Kellogg (IFDAM), Krall (PHYS), Lynn (MATH—UMBC), Melnick (AERO), Misner (PHYS), Newcomb (EE), Olver (IFDAM), Ortega (CSC), Pearl (MATH), Prange (PHYS), Rheinboldt (CSC), Stellmacher (MATH), Strauss (MATH), Sucher (PHYS), Weiss (EE, IFDAM), Yang (ME), Yorke (IFDAM), Zwanzig (IFDAM).

Associate Professors: Cooper (MATH), Dragt (PHYS), Fivel (PHYS), Gentry (CHE), Hall (CE), Johnson (MATH), Kim (PHYS), Marks (ME), Murino (CHE), Osborn (MATH), Plotkin (AERO), Sather (MATH), Schaeffer (AERO), Schneider (MATH), Seidman (MATH—UMBC), Sheaks (CHE), Sternberg (CE), Vandergraft (CSC), Wolfe (MATH), Woo (PHYS).

Assistant Professors: Agrawala (CSC), Anderson, Jr. (MATH), Ephremides (EE), Kugelman (CHE), MacRae (ECON), McCuen (CE), Scheffler (ME), Sweet MATH), Weisshaar (AERO).

The Graduate Program in Applied Mathematics offers training in the modern applications of mathematics to students from both the College Park and Baltimore County Campuses. This interdisciplinary program is designed to permit the student to combine the study of mathematics with a chosen field of application. It emphasizes the development and use of mathematics in analyzing specific problems. Students are expected to attain a definite level of competence in the chosen field of application as well as in the areas of applicable mathematics which are used therein. In addition, they are expected to attain a broad base in the related areas of mathematics, and in the modern computing techniques relevant to the field of application. Opportunities for thesis research exist in many areas within the physical, social, and life sciences as well as within the various engineering disciplines.

Instruction is conducted by selected faculty in the Computer Science Center (CSC), the Institute for Fluid Dynamics and Applied Mathematics (IFDAM), the Department of Mathematics (MATH), the Department of Physics (PHYS), the Department of Aerospace Engineering (AERO), the Department of Chemical Engineering (CHE), the Department of Civil Engineering (CE), the Department of Electrical Engineering (EE), the Department of Mechanical Engineering (ME), the Department of Economics (ECON), plus others on the College Park Campus, together with certain faculty in the Division of Mathematics at the Baltimore County Campus. These faculty constitute the graduate faculty in applied mathematics, which is coordinated by the graduate Committee for Applied Mathematics. Students may enter the Graduate Program in Applied Mathematics through either of the two cooperating campuses. Inquiries should be directed to the Chair-

man of the Executive Committee for Applied Mathematics.

Because of the breadth of applied mathematics and the great variety of study options in this program, a small group of faculty is designated to draft a specific course of study for each student. Each student must take at least 24 hours of graduate instruction, of which at least 12 must be in areas of basic mathematics and at least 6 hours must be in areas of application plus thesis research to complete the M.S. degree. The Ph.D. degree demands thesis research plus a minimum of 36 hours of graduate instruction, of which at least 18 hours must be in basic mathematics and at least 9 hours in graduate instruction in applications. Mathematical instruction is also offered through the program for students of other disciplines. Inquiries in such cases should be directed to the chairman of the department in which the student will be working for a graduate degree.

MEASUREMENT AND STATISTICS PROGRAM

Professor and Chairman: Giblette
Professors: Dayton, Stunkard
Associate Professors: Johnson, Sedlacek
Assistant Professors: MacReady, Rogers, Schafer

In the Department of Measurement and Statistics, programs are available at both the masters and doctoral levels for persons desiring a major in research design, measurement and statistics in education. In addition, a doctoral minor is offered for students majoring in other areas. Each of these programs is designed to integrate the three areas of research design, measurement and statistics.

The doctoral major program is primarily intended to produce individuals qualified to teach courses at the college level in educational research, measurement and statistics; conduct research studies in the field of education; advise in the conduct of research studies; and serve as measurement specialists in school systems, industry and government. The master's level program is designed to produce qualified individuals to serve as junior statisticians in various fields and to provide qualified test administration, scoring, and interpretation services (both the thesis and non-thesis option are offered). Courses within the program are selected from offerings of the College of Education and other departments of the University. A program for an individual student is planned to take into account his own background and future aims. About half the work within the major is elected to meet the needs and special interests of the individual student.

Persons planning a college teaching career will have opportunity to engage in supervised activities appropriate for future faculty members whose specialization will be in these areas. Research experience utilizing modern electronic data processing equipment will be obtained.

EDMS 410. PRINCIPLES OF TESTING AND EVALUATION (3)
Basic principles including the steps in the specification of instructional objectives and subsequent development of teacher-made tests; problems in the use and interpretation of achievement and aptitude tests; introduction to the development and use of non-testing evaluation procedures; basic considerations in the assignment of marks and grades; introduction to computer technology as applied to measurement.

EDMS 446. QUANTITATIVE RESEARCH METHODS (3)
An introduction to research design principles and the scientific method as applied to behavioral phenomena. Instrumentation procedures including the planning and construction of simple data collection instruments and their analysis, and assessment of the reliability and validity of such instruments, statistical procedures appropriate to the analysis of data from simple research designs. Laboratory experiences in instrumentation and research design are emphasized.

EDMS 451. INTRODUCTION TO EDUCATIONAL STATISTICS (3)
Designed as a first course in statistics for students in education. Emphasis is upon educational applications of descriptive statistics, including measures of central tendency, variability and association. Also included are inferential statistics through one-way anova.

EDMS 465. ALGORITHMIC METHODS IN EDUCATIONAL RESEARCH (3)
Introduction to the use of the computer as a tool in educational research. Instruction in a basic scientific computer source language as well as practical experience in program writing for solving statistical and educational research problems.

EDMS 622. THEORY AND PRACTICE OF STANDARDIZED TESTING (3)
Prerequisite, EDMS 410, 446 or 451. Study of group tests typically employed in school testing programs; discussion of evidence relating to the measurement of abilities; practice in standardized group test administrations.

EDMS 626. MEASUREMENT TECHNIQUES FOR RESEARCH (3)
Theory, development and applications of various measurement instruments and procedures used in educational research. Questionnaires, interviews, rating scales, attitude scales, observational procedures, ecological approaches, Q-sort, semantic-differential, sociometry and other approaches. Prerequisite, EDMS 451 or 646.

EDMS 646. QUANTITATIVE RESEARCH METHODS II (3)
Prerequisite, EDMS 446. Special problems arising in the implementation of educational research designs. Instrumentation to measure attitudes and collection of questionnaire data. Additional statistical procedures appropriate to the analysis of education research designs. Laboratory experiences in instrumentation and research design are emphasized.

EDMS 651. INTERMEDIATE STATISTICS IN EDUCATION (3)
Distributional theory; Chi-square analysis of contingency tables; analysis of variance; introduction to multiple correlation and regression.

EDMS 653. CORRELATION AND REGRESSION ANALYSIS (3)
Prerequisite, EDMS 651. Systematic development of simple regression, multiple regression, and non-linear regression as applied to educational research problems. Emphasis is on underlying theory of procedures and on analytical approaches which are amenable to computerization.

EDMS 723. MEASUREMENT THEORY I (3)
Prerequisite, EDMS 410, 451, or 646. Classical measurement theory dealing with the nature of measurement, principles and procedures concerning the accuracy of measurement and prediction, reliability, and validity theory.

EDMS 724. MEASUREMENT THEORY II (3)
Theoretical formulations of reliability, validity and scaling as related to problems in measurement theory and prediction. Prerequisites, EDMS 651, 723.

EDMS 726. PRACTICUM IN INDIVIDUAL TESTING I (3)
Prerequisite, EDMS 622. The administration and interpretation of the Stanford-Binet and Wechsler scale of intelligence.

EDMS 727. PRACTICUM IN INDIVIDUAL TESTING II (3)
Prerequisite, EDMS 622 or consent of the instructor. Provides practicum experience in the administration of and the interpretation of the results of individual psychological tests. Designed to familiarize the student with alternate instruments to the Stanford-Binet and Wechsler scales of intelligence as well as to introduce the measurement of special abilities through the use of appropriate instruments.

EDMS 738. SEMINAR IN SPECIAL PROBLEMS IN MEASUREMENT (1-3)
Prerequisite, consent of the instructor. An opportunity for students with special interests to focus in depth on contemporary topics in measurement. Topics to be announced, but will typically be related to applied and theoretical measurement.

EDMS 769. SPECIAL TOPICS IN APPLIED STATISTICS IN EDUCATION (1-4)
Prerequisite, EDMS 771 or equivalent, and consent of instructor. Designed primarily for students majoring or minoring in measurement and statistics in education. Topics to be announced, but will typically relate to the areas of advanced multivariate analysis and advanced design of experiments.

EDMS 771. DESIGN OF EXPERIMENTS (3)
Prerequisite, EDMS 651 or equivalent. Primarily for the education student desiring more advanced work in statistical methodology. Survey of major types of statistical design in educational research; application of multivariate statistical techniques to education problems.

EDMS 779. SEMINAR IN APPLIED STATISTICS (1-3)
Enrollment restricted to doctoral students with a major or minor in measurement and statistics. Seminar topics will be chosen in terms of individual student interest.

EDMS 780. RESEARCH METHODS AND MATERIALS (3)
Research methodology for case studies, surveys, and experiments; measurements and statistical techniques. Primarily for advanced students and doctoral candidates.

EDMS 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number.

EDMS 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for master's thesis.

EDMS 879. DOCTORAL SEMINAR (1-3)
Prerequisite, passing the preliminary examinations for a Doctor's Degree in education, or recommendation of a doctoral advisor. Analysis of doctoral projects and theses, and of other on-going research projects. A doctoral candidate may participate in the seminar during as many university sessions as he desires, but may earn no more than three semester hours of credit accumulated one hour at a time in the seminar. An Ed.D. candidate may earn in total no more than nine semester hours, and a Ph.D. candidate, no more than eighteen semester hours, in the seminar and in EDMS 899.

EDMS 888. APPRENTICESHIP IN MEASUREMENT AND STATISTICS (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's degree in Education, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDMS 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDMS 889. INTERNSHIP IN MEASUREMENT AND STATISTICS (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the doctor's degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor main-

tains a close working relationship with the intern and the other persons involved. *NOTE:* The total number of credits which a student may earn in EDMS 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDMS 899. DOCTORAL DISSERTATION

RESEARCH (1-8)
Six to nine hours required for an EdD project and 12-18 hours required for a PhD dissertation.

MECHANICAL ENGINEERING PROGRAM

Professor and Chairman: Dally
Professors: Allen, Anand, Armstrong, Asimow, Berger, Cunniff, Hsu, Irwin, Jackson, Marcinkowski, Sayre, Shreeve, Talaat, Yang
Associate Professors: Buckley, Fourney, Hayleck, Marks, Morse, Sallet, Walston
Assistant Professors: Forsnes, Holloway, Kirk, Kobayashi, Owens, Sargent, Scheffler, Tsui
Lecturers: Dawson, Seigel

The Mechanical Engineering Department offers programs which lead to the degrees of Master of Science and Doctor of Philosophy. Programs are offered in four different areas of specialization including: 1) Energy, 2) Fluid Mechanics, 3) Industrial and Systems Engineering, and 4) Solid Mechanics. Each graduate student should select one of the areas of specialization at his first registration so that a suitable program leading to a degree can be planned.

1) *Energy.* This area of specialization treats the transformation, transportation and utilization of all types of energy. The area encompasses three main topics which include heat and mass transfer, thermodynamics, and energy conversion.

2) *Fluid Mechanics.* The programs of study in Fluid Mechanics are designed to provide a broad fundamental base structured around a background of mathematical techniques applicable to a wide variety of fluid problems. The program provides for an in-depth theoretical study of the inviscid and viscous flow of compressible and incompressible fluids.

3) *Industrial and Systems Engineering.* This area of specialization combines fields of science and technology for the purposes of analysis, synthesis, design and management of complex systems. In addition to traditional applications to communication, transportation and aerospace systems and production processes, this area of specialization finds increased application in economics, biomedical engineering and urban problems. The graduate program is organized to include a variety of courses in control systems, operations research, design, and industrial engineering.

4) *Solid Mechanics.* This area of specialization provides an opportunity for preparation in advanced analytical and experimental methods in mechanics. In this area, the emphasis is usually placed on the development of methods and procedures with the application following the understanding of the fundamental principles. Areas of study include continuum mechanics, dynamics, vibrations, acoustics, stress waves, elasticity, plasticity, linear and non-linear mechanics, experimental mechanics, and fracture mechanics.

Although there are minor variations in the general requirements for programs in the different technical areas, the requirements listed below can be used as a guide for initial planning.

The degree requirements for the Master of Science program include 30 semester hours distributed as follows: 12-15 semester hours of courses within the area of interest; 3-6 semester hours of mathematics (normally selected from among MATH 463, 464, 415, 460, STAT 400, 401, EMME 700, or 701, according to needs and previous preparation); 6-9 semester hours in another area of interest of the Mechanical Engineering Department or from courses outside the department; and 6 semester hours of thesis or six additional course hours in the area of interest plus a paper on a topic selected in consultation with the student's committee.

A Ph.D. program normally consists of 12 semester hours of dissertation research plus a suggested minimum of 48 semester hours of course work (24 semester hours beyond the M.S.), usually 24 semester hours as a major within one of the areas of interest in the Mechanical Engineering Department. Groups require 9-18 hours of prescribed fundamental courses plus 6-15 hours of advanced or specialized courses selected in consultation with an advisory committee. A total of 24 semester hours is allowed for a minor. This minor requirement is generally split between mathematics and one other area of specialization. Groups require 6-12 semester hours in mathematics (or statistics). The remaining semester hours would be devoted to a coherent group of courses from within or outside of the Mechanical Engineering Department selected by the student in consultation with his advisory committee.

Each candidate for the doctoral degree must submit a dissertation on a topic selected from the student's major subject. Each candidate must satisfactorily complete an oral and written examination. The oral examination normally consists of a "defense of thesis" and may include discussions of pertinent course material.

ENME 400. MACHINE DESIGN (3)
Two lectures and one laboratory period a week. Prerequisite, ENME 300, 360. Working stresses, stress concentration, stress analysis and repeated loadings. Design of machine elements. Kinematics of mechanisms.

ENME 401. MECHANICAL ENGINEERING ANALYSIS AND DESIGN (4)
Two lectures and two laboratory periods per week. Prerequisite, senior standing in Mechanical Engineering or consent of instructor. Engineering design practice as illustrated by discussions of selected case studies. Design projects involving the application of technology to the solution of industrial and community problems. Legal and ethical responsibility of the designer.

ENME 402. SELECTED TOPICS IN ENGINEERING DESIGN (3)
Three lecture periods per week. Prerequisite, senior standing in Mechanical Engineering or consent of instructor. Creativity and innovation in design. Generalized performance analysis, reliability and opti-

mization as applied to the design of components and engineering systems. Use of computers in design. Design of multivariable systems.

ENME 403. AUTOMATIC CONTROLS (3)
Three lectures per week. Prerequisites, ENEE 300, senior standing. Hydraulic, electrical, mechanical and pneumatic automatic control systems. Open and closed loops. Steady state and transient operation, stability criteria, linear and non-linear systems. Laplace transforms.

ENME 410. OPERATIONS RESEARCH I (3)
Three lectures a week. Prerequisite, senior standing in Mechanical Engineering. Applications of linear programming, queueing model, theory of games and competitive models to engineering problems.

ENME 411. INTRODUCTION TO INDUSTRIAL ENGINEERING (3)
Three lectures per week. Prerequisites, ENME 300 and ECON 205 or consent of instructor. This course is concerned with the design, improvement and installation of integrated systems of men, materials and equipment. Areas covered include industrial activities, plant layout and design, value analysis, engineering economics, quality and production control, methods engineering, industrial relations, etc.

ENME 420. ENERGY CONVERSION (3)
Three lectures a week. Prerequisite, ENME 320. Required of seniors in Electrical Engineering. Chemical, heat, mechanical, nuclear and electrical energy conversion processes, cycles and systems. Direct conversion processes of fuel cells, thermionics and magnetohydromechanics.

ENME 421. ENERGY CONVERSION I (3)
Three lectures a week. Prerequisites, ENME 321, ENME 342. Application of the principles of thermodynamics, fluid mechanics and heat transfer to chemical, thermal, mechanical, nuclear and electrical energy conversion processes, cycles and systems. Reciprocating, turbine and rocket power plants using all types of heat and reaction sources. Environmental effects of energy conversion processes.

ENME 422. ENERGY CONVERSION II (3)
Three lectures a week. Prerequisite, ENME 421. Advanced topics in energy conversion. Direct conversion processes of fuel cells, solar cells, thermionics, thermoelectrics and magnetohydrodynamics.

ENME 423. ENVIRONMENTAL ENGINEERING (3)
Three lectures a week. Prerequisites, ENME 321, 360, senior standing in Mechanical Engineering. Heating and cooling load computations. Therodynamics of refrigeration systems. Low temperature refrigeration. Problems involving extremes of temperature pressure, acceleration and radiation.

ENME 424. THERMODYNAMICS II (3)
Three lectures a week. Prerequisites, ENME 321, senior standing. Applications to special systems, change of phase, low temperature. Statistical concepts, equilibrium, heterogeneous systems.

ENME 442. FLUID MECHANICS II (3)
Three lectures a week. Prerequisite, ENME 342, senior standing. Hydrodynamics with engineering applications. Stream function and velocity potential, conformal transformations, pressure distributions, circulation, numerical methods and analogies.

ENME 450. MECHANICAL ENGINEERING ANALYSIS FOR THE OCEANIC ENVIRONMENT (3)
Prerequisite, junior standing. Study of the characteristics of the marine environment which affect the design, operation and maintenance of mechanical equipment, effects of waves, currents, pressure, temperature, corrosion, and fouling. Study of design parameters for existing and proposed mechanical systems used in marine construction, on shipboard, in search and salvage operations.

ENME 451. MECHANICAL ENGINEERING SYSTEMS FOR UNDERWATER OPERATIONS (3)
Prerequisite, ENME 450 or consent of instructor. Study of propulsion, control and environmental systems for submerged vehicles. Design of mechanical systems in support of diving and saturated living operations.

ENME 452. PHYSICAL AND DYNAMICAL OCEANOGRAPHY (3)
Prerequisites, consent of the instructor. Historical review of oceanography. Physical, chemical, stratification and circulation properties of the ocean; dynamics of frictionless, frictional, wind driven and thermohaline circulations; air-sea interactions.

ENME 453. OCEAN WAVES, TIDES AND TURBULENCES (3)
Prerequisite, METO 420 or consent of instructor. Introduction to the theory of oceanic wave motions, tides, wind waves, swells, storm surges, seiches, tsunamis, internal waves, turbulence, stirring, mixing and diffusion.

ENME 460. ELASTICITY AND PLASTICITY I (3)
Three lectures a week. Prerequisite, ENME 400. Analysis of plates and shells, thick walled cylinders, columns, torsion of non-circular sections, and rotating dicks.

ENME 461. DYNAMICS II (3)
Three lectures a week. Prerequisites, ENME 360, differential equations, senior standing in mechanical engineering. Linear and non-linear plane and three-dimensional motion, moving axes, Lagrange's equation, Hamilton's principle, non-linear vibration, gyroscope, celestial mechanics.

ENME 462. INTRODUCTION TO ENGINEERING ACOUSTICS (3)
Three lectures per week. Prerequisite, ENME 380 or equivalent. Study of the physical behavior of sound waves. Introduction to terminology and instrumentation used in acoustics. Criteria for noise and vibration control. Some fundamentals underlying noise control and applications to ventilation systems, machine and shop quieting, office buildings, jet noise, transportation systems and underwater sound.

ENME 463. MECHANICAL ENGINEERING ANALYSIS (3)
Three lectures a week. Prerequisite, ENME 380, or MATH 246. Mathematical modeling of physical

situations. Solutions of problems expressed by partial differential equations. Application of Fourier series and integrals, Laplace transformation, Bessel functions, Legendre polynomials and complex variables to the solution of engineering problems in mechanical vibrations, heat transfer, fluid mechanics and automatic control theory.

ENME 465. INTRODUCTORY FRACTURE MECHANICS (3)
Three lectures per week. Prerequisite: senior standing in Engineering. An examination of the concepts of fracture in members with pre-existing flaws. Emphasis is primarily on the mechanics aspects with the development of the Griffith theory and the introduction of the stress intensity factor, K, associated with different types of cracks. Fracture phenomena are introduced together with critical values of the fracture toughness of materials. Testing procedures for characterizing materials together with applications of fracture mechanics to design are tested.

ENME 480. ENGINEERING EXPERIMENTATION (3)
One lecture and two laboratory periods a week. Prerequisite, senior standing in Mechanical Engineering. Theory of experimentation. Applications of the principles of measurement and instrumentation systems to laboratory experimentation. Experiments in fluid mechanics, solid mechanics and energy conversion. Selected experiments or assigned projects to emphasize planned procedure, analysis and communication of results, analogous systems and leadership.

ENME 481. ENGINEERING EXPERIMENTATION (3)
One lecture and two laboratory periods a week. Prerequisite, senior standing in Mechanical Engineering. Theory of experimentation. Applications of the principles of measurement and instrumentation systems of laboratory experimentation. Experiments in fluid mechanics, solid mechanics and energy conversion. Selected experiments or assigned projects to emphasize planned procedure, analysis and communication of results, analogous systems and leadership.

ENME 488. SPECIAL PROBLEMS (3)
Three lectures a week. Prerequisite, senior standing in Mechanical Engineering. Advanced problems in Mechanical Engineering with special emphasis on mathematical and experimental methods.

ENME 489. SPECIAL TOPICS IN MECHANICAL ENGINEERING (3)
Prerequisite, permission of instructor. May be taken for repeated credit up to a total of 6 credits, with the permission of the student's advisor. Selected topics of current importance in Mechanical Engineering.

ENME 600. ADVANCED MECHANICAL ENGINEERING DESIGN (3)
Three lectures per week. Synthesis of stress analysis and properties and characteristics of materials as related to design. Areas covered: combined stress designs, optimizations, composite structures, stress concentrations, design under various environmental conditions, metal working, limit analysis, etc. Review of design literature, design project.

ENME 601. ADVANCED MECHANICAL ENGINEERING DESIGN (3)
Prerequisite, ENME 600. Three lectures per week. Synthesis of stress analysis and properties and characteristics of materials as related to design. Areas covered: combined stress designs, optimizations, composite structures, stress concentrations, design under various environmental conditions, metal working, limit analysis, etc. Review of design literature, design project.

ENME 602. CONTROL SYSTEMS ANALYSIS AND SYNTHESIS (3)
Two lectures per week. Prerequisite, undergraduate automatic control theory background. Linear control systems analysis and synthesis using time frequency domain techniques: flow graphs, error coefficients, sensitivity, stability, compensation to meet specifications, introduction to sampled data systems.

ENME 603. NON-LINEAR AND ADAPTIVE CONTROL SYSTEMS (3)
Two lectures per week. Prerequisite, ENEE 602, ENME 660 or equivalent. Approximate analysis of non-linear systems using series, perturbation, and linearization techniques; introduction to state space formulation of differential equations; systems with stochastic inputs; stability, introduction to optimum switched systems; adaptive control systems.

ENME 620, 621. ADVANCED THERMODYNAMICS (3, 3)
Three lectures per week. Prerequisite, ENME 421. Advanced problems in therodynamics on compression of gases and liquids, combustion and equilibrium, humidification and refrigeration and availability. Statistical thermodynamics, partition functions, irreversible processes. Transport phenomena.

ENME 622, 623. ENERGY CONVERSION-SOLID STATE (3, 3)
Three lectures per week. Prerequisite, ENME 421. Combustion, thermo-electric, thermionic fuel cells, reactors, magnetohydrodynamics, kinetics of reactors, fission and fusion.

ENME 624, 625. ENERGY CONVERSIONS-PLASMA STATE (3, 3)
Three lectures per week. Prerequisite, ENME 421. Design parameters in chemical, nuclear and direct conversion systems for the production of power, weight, efficiency and radiation.

ENME 626, 627. ADVANCED HEAT TRANSFER (3, 3)
Three lectures per week. Prerequisites, ENME 321, 342, 343. Advanced problems covering effects of radiation, conduction, convection, evaporation and condensation. Study of research literature on heat transfer.

ENME 640. ADVANCED FLUID MECHANICS (3)
Three lectures per week. Prerequisites, ENME 380. or MATH 246 and ENME 340. Potential flow theory, three-dimensional flow examples, application of complex variables to two-dimensional flow problems, Blasius theorem, circulation and Joukowski hypothesis, engineering applications to cavitation and calculation of pressure distribution, viscous flow and boundary layer.

ENME 641. ADVANCED FLUID MECHANICS (3)
Three lectures per week. Prerequisite, ENME 640. Potential flow theory, three-dimensional flow examples, application of complex variables to two-dimension flow problems, Blasius theorem, circulation and Joukowski hypothesis, engineering applications to cavitation and calculation of pressure distribution, viscous flow and boundary layer.

ENME 642. COMPRESSIBLE FLOW (3)
Three lectures per week. Prerequisite, ENME 341 and MATH 246, or ENME 380. One dimensional subsonic and supersonic flow, similarity rules, normal and oblique shock waves.

ENME 643. COMPRESSIBLE FLOW (3)
Three lectures per week. Prerequisite, ENME 642. One dimensional subsonic and supersonic flow, similarity rules, normal and oblique shock waves.

ENME 644. VISCOUS FLOW (3)
Prerequisites, ENME 640, 641. Three lectures per week. Derivation of Navier Stokes equations, some exact solutions. Boundary layer equations. Laminar flow-similar solutions, compressibility transformations, analytic approximations, numerical methods. Stability and transition to turbulent flow. Turbulent flow-isotropic turbulence, boundary layer flow, free mixing flows. This course is equivalent to ENAE 675, 676.

ENME 645. VISCOUS FLOW (3)
Prerequisite, ENME 644. Three lectures per week. Derivation of Navier Stokes equations, some exact solutions. Boundary layer equations. Laminar flow-similar solutions, compressibility transformations, analytic approximations, numerical methods. Stability and transition to turbulent flow. Turbulent flow-isotropic turbulence, boundary layer flows, free mixing flows. This course is equivalent to ENAE 675, 676.

ENME 646. SPECIAL TOPICS IN UNSTEADY HYDRODYNAMICS (3)
Three lectures per week. Prerequisites, ENME 640, 641. Treatment in depth of several topics in unsteady hydrodynamics such as sloshing in liquid tanks, seismic effects in liquids in large containers and reservoirs, and stationary surface wave phenomena during natural and forced oscillation. Examination of the effects of non-linearities in surface boundary conditions, low gravity and rotation on fluid behavior. Emphasis on the use of theoretical fundamentals and techniques including numerical methods to solve practical problems. The use of high speed computers will be featured in numerical solutions wherever practicable.

ENME 650. DESIGN OF TURBOMACHINERY (3)
Three lectures per week. Prerequisite, ENME 422. Characteristics and design of turbines, pumps, compressors and torque convertors; cavitation, stall, and surge.

ENME 660. INTERMEDIATE DYNAMICS (3)
Three lectures per week. Fundamentals of Newtonian dynamics which includes kinematics of a particle, dynamics of a particle and a system of particles, Hamilton's principle, Lagrange's equations, basic concepts and kinematics of rigid body motion, dynamics of planar rigid body motion. Applications to mechanical engineering problems.

ENME 661. ADVANCED DYNAMICS (3)
Three lectures per week. Prerequisite, ENME 660. Dynamics of three-dimensional rigid body motion. Application of Euler's angles to rigid body motion. Hamilton's equation. Dynamics of gyroscopic instruments. Vibration theory of linear lumped mass systems. Satellite orbits and space vehicle motion. A review of current problems under investigation by research workers.

ENME 662. LINEAR VIBRATIONS (3)
Three lectures a week. Fourier and statistical analysis, transient, steady-state, and random behavior of linear lumped mass systems. Normal mode theory; shock spectrum concepts; mechanical impedance and mobility methods. Vibrations of continuous media including rods, beams, and membranes.

ENME 663. NONLINEAR VIBRATIONS (3)
Three lectures per week. Prerequisite, ENME 662. Geometrical and numerical analysis of non-linear systems. Stability, limit cycles. Theory of bifurcations. Perturbation method. Periodic solutions. Oscillations in systems with several degrees of freedom. Asymptotic methods. Non-linear resonance. Relaxation oscillations. Self-excited vibrations.

ENME 666, 667. STRESS WAVES IN CONTINUOUS MEDIA (3, 3)
Three lectures per week. Methods of characteristics applied to transient phenomena in solids and fluids. Elastic and plastic waves under impact. Shock formation and strain rate effects.

ENME 670. CONTINUUM MECHANICS (3)
Three lectures a week. The algebra and calculus of tensors in Riemannian space are developed with special emphasis on those aspects which are most relevant to mechanics. The geometry of curves and surfaces in E-3 is examined. The concepts are applied to the derivation of the field equations for the non-linear theory of continuous media and to various problems arising in classical dynamics.

ENME 671. LINEAR THEORY OF ELASTICITY (3)
Three lectures per week. The basic equations of the linear theory are developed as a special case of the non-linear theory. The first and second boundary value problems are discussed together with the problem of uniqueness. Solutions are constructed to problems of technical interest through semi-inverse, transform and potential methods. Included are the study of plane problems, torsion, dynamic response of spherical shells and tubes, microstructure and anisotropic materials.

ENME 672. PLASTICITY (3)
Three lectures per week. Yield criterion and associated flow rules as related to the behavior of materials in the elastic-inelastic region for both perfectly plastic and strain hardenable materials. Plastic behavior of members in the following areas including, instability, bending, torsion, cylinders, spheres, curved members, limited analysis, analysis and metal working theory and applications.

ENME 673. PLASTICITY (3)
Three lectures per week. Prerequisite, ENME 672. Yield criterion and associated flow rules as related to the behavior of materials in the elastic-inelastic region for both perfectly plastic and strain hardenable materials. Plastic behavior of members in the following areas including, instability, bending, torsion, cylinders, spheres, curved members, limit analysis and metal working theory and applications.

ENME 674. NON-LINEAR ELASTICITY (3)
Three lectures per week. Prerequisite, ENME 670. Treats those materials for which the stress at time T depends only on the local configuration at time T. The constitutive equations are developed for elastic and hyperelastic materials through the application of the various invariance requirements. Exact solutions for special nonlinear problems are developed. Plane problems, infinitesimal strain superimposed on a given finite strain, wave propagation and stability problems are considered.

ENME 675. VISCOELASTICITY (3)
Three lectures per week. Prerequisite, ENME 670. Treats the behavior of solid materials which possess fluid characteristics. Included within this group are Green-Revlin and hygrosteric materials. The study of objective tensor rates and other invariance requirements leads to the formulation of constitutive equation for variance viscoelastic materials. Steady shear flows, helical flow, viscoelastic torsion and problems arising from the linear viscoelastic theory are considered.

ENME 676. LINEAR AND NONLINEAR ELASTIC SHELLS (3)
Three lectures per week. Prerequisite, knowledge of the equations of elasticity. Fundamental results from the theory of surfaces. Theories of shells composed of linear and non-linear elastic materials. Discussion of both infinitesimal and finite deformation states. Strain displacement relationships developed to include higher order terms. Derivation of equilibrium equations and their use in static and dynamic stability studies. Constitutive equations for the linear theory. Solutions to special shell problems.

ENME 678. FRACTURE MECHANICS (3)
An advanced treatment of fracture mechanics covering in detail the analysis concepts for determining the stress intensity factors for various types of cracks. Advanced experimental methods for evaluation of materials or structures for fracture toughness. Analysis of moving cracks and the statistical analysis of fracture strength. Finally, illustrative fracture control plans are treated to show the engineering applications of fracture mechanics.

ENME 700. ADVANCED MECHANICAL ENGINEERING ANALYSIS I (3)
An advanced, unified approach to the solution of advanced mechanical engineering problems. Emphasis is on the formulation and solution of equilibrium, eigenvalue and progagation problems. Review and extension of undergraduate material in applied mathematics with emphasis on problems in heat transfer, vibrations, fluid flow and stress analysis which may be formulated and solved by classical procedures.

ENME 701. ADVANCED MECHANICAL ENGINEERING ANALYSIS II (3)
Formulation and solution of Mechanical Engineering problems. Analysis of oscillatory and non-oscillatory systems utilizing discrete parameter techniques including matrix methods, finite element methods, finite differences and numerical integration. Study of non-linear vibration and control systems with emphasis on perturbation theory and stability analysis. Engineering applications of statistical analysis.

ENME 760, 761. ADVANCED STRUCTURAL DYNAMICS I (3, 3)
Advanced topics in structural dynamics analysis: dynamic properties of materials, impact and contact phenomena, wave propagation, modern numerical methods for complex structural systems, analysis for wind and blast loads, penetration loads, and earthquake, non-linear systems, random vibrations and structural failure from random loads.

ENME 788. SEMINAR (1-16)
Credit in accordance with work outlined by Mechanical Engineering staff. Prerequisite, graduate standing in Mechanical Engineering.

ENME 799. MASTER'S THESIS RESEARCH (1-6)

ENME 808. ADVANCED TOPICS IN MECHANICAL ENGINEERING (2-3)

ENME 899. DOCTORAL DISSERTATION RESEARCH (1-8)

METEOROLOGY PROGRAM

Research Professor and Chairman: Landsberg
Associate Professors: Israel,[1] Rodenhuis, Thompson, Vernekar
Research Professor: Faller
Visiting Professor: Fritz
Visiting Lecturer: Gerrity
[1] joint appointment with Civil Engineering

The Graduate Program in Meteorology offers unusually broad opportunities to students pursuing an advanced course of study due to close relationship between the activities of the program and the scientific activities of various institutes and laboratories on and off Campus.

The Graduate Program in Meteorology offers a course of study leading to the degrees of Master of Science and Doctor of Philosophy, and is open to students holding the Bachelor's degree in chemistry, mathematics, physics, astronomy, engineering, or other programs with suitable emphasis in the sciences. Previous education in meteorology or related sciences will be favorably considered in a student's application for admission to the program; however, such education or experience is not a prerequisite. In exceptional circumstances a student holding the baccalaureate degree in other fields may be admitted subject to satisfactory completion of prescribed background courses.

Courses in the major subject area may be selected from those courses listed under Meteorology. Courses to satisfy the minor requirements may be chosen in physics, astronomy, mathematics, applied mathema-

tics, fluid dynamics, engineering or in other areas of special interest. The student's program will be supervised by a member of the Meteorology teaching faculty. Research problems in meteorology will be supervised by members of the Institute for Fluid Dynamics and Applied Mathematics, or by a faculty member of another appropriate department. Under special circumstances, the research may be conducted in an off-campus laboratory with professional supervision.

The laboratories are well equipped and include elaborate apparatus for fluid dynamics experiments in rotating systems, a tank for studying the interaction of water waves and wind, continuous weather facsimile data, a complete solar radiation station on the roof of the building, several micro-meteorological field stations, and use of common shop facilities in the Institute for Fluid Dynamics and Applied Mathematics.

There is, within the meteorology office grouping, a specialized library with several hundred text and reference books in meteorology and allied sciences, many specialized series of research reports (i.e., contract reports, etc.) and many current journals in meteorology and related fields. Access to the vast holdings of the Atmospheric Sciences Library of NOAA at Silver Spring, Maryland, within about 20 minutes of the Campus, has been arranged.

The University of Maryland is a member of the University Corporation for Atmospheric Research and as such, enjoys the common facilities offered by the National Center for Atmospheric Research at Boulder, Colorado. The University has also signed Memoranda of Agreements with NOAA, Naval Research Laboratory and the National Bureau of Standards.

METO 410. DESCRIPTIVE AND SYNOPTIC METEOROLOGY (3)
Prerequisites, MATH 241, PHYS 284 or equivalent. A survey of atmospheric phenomena, goals of research and techniques of study. This course would introduce the new student to the broad range of theoretical and applied studies in meteorology in order to acquaint him with the interaction of the physical and dynamical processes and the various scales of atmospheric phenomena. Some work in synoptic analysis and an introduction to methods of forecasting would be included.

METO 411. DESCRIPTIVE AND SYNOPTIC METEOROLOGY (3)
Prerequisite, METO 410. A survey of atmospheric phenomena, goals of research and techniques of study. This course would introduce the new student to the broad range of theoretical and applied studies in meteorology in order to acquaint him with the interaction of the physical and dynamical processes and the various scales of atmospheric phenomena. Some work in synoptic analysis and an introduction to methods of forecasting would be included.

METO 412. PHYSICS AND THERMODYNAMICS OF THE ATMOSPHERE (3)
Prerequisites, MATH 241, PHYS 284 or equivalent. Optical phenomena, the radiation balance, introduction to cloud physics, atmospheric electrical phenomena, basic thermodynamic processes and their application to the atmosphere.

METO 420. PHYSICAL AND DYNAMICAL OCEANOGRAPHY (3)
Prerequisite, METO 410 or a basic course in fluid dynamics such as ENME 340. Historical review of oceanography; physical, chemical, stratification and circulation properties of the ocean; dynamics of frictionless, frictional, wind driven and thermohaline circulation; air-sea interactions.

METO 422. OCEANIC WAVES, TIDES AND TURBULENCE (3)
Prerequisite, METO 420. Introduction to the theory of oceanic wave motions; tides, wind waves, swells, storm surges, seiches, tsunamis, internal waves, turbulence, stirring, mixing and diffusion; probability, statistics and time series.

METO 434. AIR POLLUTION (3)
Prerequisite, senior standing in science or engineering or consent of the instructor. Three lectures per week. Classification of atmospheric pollutants and their effects on visibility, inanimate and animate receptors. Evaluation of source emissions and principles of air pollution control; meteorological factors governing the distribution and removal of air pollutants; air quality measurements and air pollution control legislation.

METO 610. DYNAMIC METEOROLOGY I (3)
Prerequisite, MATH 411, METO 411 or equivalent. The equations of fluid motion; circulation and vorticity theorems; geostrophic, cyclostrophic and inertial motions; the thermal wind equations; boundary layer flow; potential vorticity and the Rossby wave speed equation; Perturbation Theory and an introduction to atmospheric turbulence; the momentum and energy balance of the general circulation.

METO 611. DYNAMIC METEOROLOGY II (3)
Prerequisite, METO 610 or equivalent. Barotropic and baroclinic instability; theories of the general circulation of the atmosphere; wave motions induced by topography and thermal asymmetries; mountain waves, thermal convection and other selected topics.

METO 612. ATMOSPHERIC TURBULENCE AND DIFFUSION (3)
Prerequisites, METO 610 or equivalent. Statistical description of turbulence; the profiles of temperature and wind near the ground; the vertical transport of momentum, heat and water vapor; spectra and scales of atmospheric turbulence; recent theories of turbulent shear flow and convection.

METO 614. NUMERICAL WEATHER PREDICTION (3)
Prerequisites, METO 611 or equivalent. Numerical techniques for the solution of partial differential equations; application to the equations of atmospheric motion; Eulerian, Lagrangian and Spectral methods; numerical models of the general circulation; current applications to research and forecasting.

METO 616. PLANETARY FLUID DYNAMICS (3)
Prerequisites, METO 412, 610 or equivalent. The structure of the atmospheres of the earth and other planets; analytical, numerical and experimental models of the circulations of planetary atmospheres and oceans; tidal motions.

METO 630. STATISTICAL METHODS IN METEOROLOGY (3)
Prerequisite, METO 411, STAT 400 or equivalent. Distribution of scalers and vectors; sampling methods; regression and correlation methods; tests of significance; time series analysis; statistical forecasting methods.

METO 634. AIR SAMPLING AND ANALYSIS (3)
Prerequisite, METO 434 or consent of instructor. Two lectures and one laboratory per week. The theory and techniques utilized in the determination of gaseous and particulate atmospheric pollutants. Reduction and representation of data and consideration in sampling site selection.

METO 640. MICRO-METEOROLOGY (3)
Prerequisites, METO 410, 411 or equivalent. A study of energy balances at the earth-atmosphere interface; statistical and spectral analysis of turbulent transfer of energy and momentum; air motions in relation to terrain and landscape; the time and spatial variations of mechanical and thermodynamical quantities in the micro-layer of the atmosphere.

METO 641. METEOROLOGY OF AIR POLLUTION (3)
Prerequisites, METO 410, 411 or equivalent. Review of basic macro- and micro-meteorological considerations; the nature and behavior of atmospheric aerosols; the description and measurement of the distribution, dispersion, and other properties of air pollution; study of the meso-meteorology of cities and the climatological influences of air pollution.

METO 658. SPECIAL TOPICS IN METEOROLOGY (1-3)
Prerequisite, consent of instructor. Various special topics in meteorology are given intensive study. The topic of concentration varies from semester to semester and depends on student and faculty interests. Often, specialists from other institutions are invited to the Campus on a visiting lectureship basis to conduct the course.

METO 659. SPECIAL TOPICS IN METEOROLOGY (1)
Prerequisite, consent of instructor. Various special topics in meteorology are given intensive study. The topic of concentration varies from semester to semester and depends on student and faculty interests. Often, specialists from other institutions are invited to the Campus on a visiting lectureship basis to conduct the course.

METO 698, 699. SEMINAR IN METEOROLOGY (1, 1)
Prerequisite, consent of instructor. This seminar will cover selected topics of current meteorological interest. Presentations will be by staff members, advanced graduate students and guest speakers.

METO 799. MASTER'S THESIS RESEARCH (1-6)

METO 899. DOCTORAL DISSERTATION RESEARCH (1-8)

MICROBIOLOGY PROGRAM

Associate Professor and Chairman: Young
Professors: Colwell, Doetsch, Faber (Emeritus) Hetrick, Laffer, Pelczar
Associate Professors: Cook, MacQuillan, Roberson
Assistant Professors: Vaituzis, Voll, Weiner
Lecturers: Janicki, Stadtman

The graduate studies program of the Department of Microbiology offers to the prospective student opportunities to extend his knowledge concerning microorganisms. Satisfactory performance in coursework is a necessary, but not sufficient, requisite for the Master of Science or Doctor of Philosophy degrees. The department expects the student to acquire the ability to demonstrate originality in his research and to understand and communicate the significance of his endeavors both orally and in writing.

Areas of specialization in the Department of Microbiology include the disciplines of applied, pathogenic, marine microbiology and systematics, bacterial cytology, physiology, metabolism, virology, immunology, and the genetics of microorganisms.

A student accepted for the M.S. program must have acquired, from an accredited college or university, a thorough foundation in the fundamental biological and physical sciences preliminary to pursuing graduate work in microbiology. In certain cases an applicant who has deficiencies may be admitted on a provisional basis. The minimum entrance requirements for graduate study in the Department of Microbiology are: Biology, 16 credits; Mathematics, 6 credits; Physics, 6 credits; Inorganic Chemistry, 8 credits and Organic Chemistry, 6 credits.

Requirements for the M.S. degree include a minimum of 24 semester hours, exclusive of research credits with a minimum grade of "B" in approved courses.

The M.S. candidate must also pass a final oral examination given by a committee of his major and minor professors. A written thesis is required of all degree recipients, and all candidates for graduate degrees are required to serve one semester as laboratory teaching assistants.

Candidates for the Ph.D. degree, in addition to the above-listed requirements, must successfully complete a written preliminary examination and an oral defense of their dissertation.

Research facilities of the Department of Microbiology include electron, phase, darkfield, interference, and ultraviolet microscopes; animal quarters, cell culture laboratories, photographic darkrooms, spectrophotometers, ultracentrifuges, gas chromatographic apparatus, and radioisotope counting equipment, as well as standard laboratory supplies and apparatus.

MICB 400. SYSTEMATIC BACTERIOLOGY (2)
Two lecture periods a week. Prerequisite, 8 credits in microbiology. History of bacterial classification; genetic relationships; international codes of nomenclature; bacterial variation as it affects classification. (Colwell)

MICB 410. HISTORY OF MICROBIOLOGY (1)
One lecture period a week. Prerequisite, a major or minor in microbiology or consent of instructor. History and integration of the fundamental discoveries of the science. The modern aspects of cytology, taxonomy, fermentation, and immunity in relation to early theories. (Doetsch)

MICB 420. EPIDEMIOLOGY AND PUBLIC HEALTH (2)
Two lecture periods a week. Prerequisite, MICB 200. History, characteristic features, and epidemiology of the important communicable diseases; public

health administration and responsibilities; vital statistics. (Faber)

MICB 440. PATHOGENIC MICROBIOLOGY (4)
Two lectures and 2 two-hour laboratory periods a week. Prerequisite, MICB 200. The role of bacteria and fungi in the diseases of man with emphasis upon the differentiation and culture of microorganisms, types of disease, modes of disease transmission, prophylactic, therapeutic, and epidemiological aspects. (Vaituzis)

MICB 450. IMMUNOLOGY (4)
Two lectures and 2 two-hour laboratory periods a week. Prerequisite, MICB 440. Principles of immunity; hypersensitiveness. Fundamental techniques of immunology. (Roberson)

MICB 460. GENERAL VIROLOGY (4)
Two lectures and 2 two-hour laboratory periods a week. Prerequisite, MICB 440 or equivalent. Basic concepts regarding the nature of viruses and their properties, together with techniques for their characterization and identification. (Hetrick)

MICB 470. MICROBIAL PHYSIOLOGY (4)
Two lectures and 2 two-hour laboratory periods a week. Prerequisites, 8 credits in microbiology and CHEM 461, 462, or equivalent. Aspects of the growth, death, and energy transactions of microorganisms are considered, as well as the effects of the physical and chemical environment on them. (MacQuillan)

MICB 490. MICROBIAL FERMENTATIONS (2)
Two lecture periods a week. Prerequisite, MICB 470. Principles and practice in industrial fermentation processes, and the study of fermentative metabolism in microorganisms. (Cook)

MICB 491. MICROBIAL FERMENTATIONS LABORATORY (2)
Two two-hour laboratory periods a week. Prerequisite, MICB 490, or concurrent registration in MICB 490, and consent of instructor. Methods for the conduct, control and analysis of fermentation processes. (Cook)

MICB 674. BACTERIAL METABOLISM (2)
Two lecture periods a week. Prerequisite, 30 credits in microbiology and allied fields, including CHEM 461 and 462. Bacterial nutrition, enzyme formation, metabolic pathways, and the dissimilation of carbon and nitrogen substrates. (MacQuillan)

MICB 688. SPECIAL TOPICS (1-4)
Prerequisite, twenty credits in microbiology. Presentation and discussion of fundamental problems and special subjects in the field of microbiology.

MICB 689. SPECIAL TOPICS (1-4)
Prerequisite, twenty credits in microbiology. Presentation and discussion of fundamental problems and special subjects in the field of microbiology.

MICB 704. MEDICAL MYCOLOGY (4)
Two lectures and 2 two-hour laboratory periods a week. Prerequisite, thirty credits in microbiology and allied fields. Primarily a study of fungi associated with disease and practice in the methods of isolation and identification. (Laffer)

MICB 714. CYTOLOGY OF BACTERIA (2)
Two lecture periods a week. Prerequisite, consent of instructor. A consideration of morphology, differentiation, and cytochemistry of the eubacterial organism. (Doetsch)

MICB 750. ADVANCED IMMUNOLOGY (2)
Two lectures a week. Antigens, antibodies, and their interactions. Research fundamentals in immunology and immunochemistry. (Roberson)

MICB 751. IMMUNOLOGY LABORATORY (2)
Two three-hour laboratory periods a week. Prerequisite, consent of the instructor. Techniques in experimental immunology and immunochemistry. (Roberson)

MICB 760. VIROLOGY AND TISSUE CULTURE (2)
Two lecture periods a week. Prerequisite, MICB 440 or equivalent. Physical, chemical and biological properties of viruses; viral replication; major virus groups. (Hetrick)

MICB 761. VIROLOGY AND TISSUE CULTURE LABORATORY (2)
Two three-hour laboratory periods a week. Prerequisite, MICB 440 or equivalent. Registration only upon consent of instructor. Laboratory methods in virology with emphasis on cell culture techniques. (Hetrick)

MICB 774. ADVANCED BACTERIAL METABOLISM (1)
One lecture period a week. Prerequisite, consent of instructor. A discussion of recent advances in the field of bacterial metabolism with emphasis on metabolic pathways of microorganisms. (Stadtman)

MICB 780. GENETICS OF MICROORGANISMS (2)
Two lecture periods a week. Prerequisite, consent of instructor. An introduction to genetic principles and methodology applicable to microorganisms. Cellular control mechanisms and protein biosynthesis. (Young)

MICB 781. MICROBIAL GENETICS LABORATORY (2)
Two three-hour laboratory periods per week. Prerequisite, consent of the instructor. A laboratory course designed to acquaint students with the techniques employed in studying gene control of microbial activities. (Young)

MICB 788. SEMINAR (1)

MICB 789. SEMINAR (1)

MICB 799. MASTER'S THESIS RESEARCH (1-6)

MICB 899. DOCTORAL DISSERTATION RESEARCH (1-8)

INSTITUTE FOR MOLECULAR PHYSICS

Professor and Director: Benesch
Professors: Benedict, Zwanzig
Associate Professors: DeRocco, Ginter, Krisher, Sengers
Assistant Professor: Gammon

The Institute for Molecular Physics comprises a faculty interested in theoretical and experimental stud-

ies in the general area of molecular structure, energetic processes, and interactions. The Institute brings together physicists and chemists to work on problems of mutual interest to the advantage of both, and the faculty is made up of members from each of these disciplines. Members of the institute teach both undergraduate and graduate courses in both the Department of Chemistry and the Department of Physics and Astronomy and supervise thesis research of graduate students in these departments.

The Institute also participates in the graduate degree program in chemical physics which is jointly administered by the Institute, the Department of Chemistry, and the Department of Physics and Astronomy. This program is open to graduate students in the Departments of Chemistry and Physics and Astronomy and offers a course of study leading to the degrees of Master of Science and Doctor of Philosophy. Entering students are expected to have an undergraduate degree in either chemistry or physics with a strong background in the other discipline. However, a mathematics or engineering major may also be eligible.

The course program will be adjusted to the needs of the individual student, who is required to pass a qualifying examination (a version of the Physics qualifier, modified to emphasize the atomic properties of matter). The successful Ph.D. student should end with a mastery of quantum mechanics, and have taken advanced courses in molecular structure (Phys. 723 or Chem. 685) and thermodynamics and intermolecular forces (Chem. 687 or 704). In keeping with the interdisciplinary nature of the Program, 9 credits in Chemistry are required from undergraduate Physics majors, and 9 credits in Physics from undergraduate Chemistry majors. Research problems in chemical physics may be supervised by the faculty in the Department of Chemistry, the Department of Physics and Astronomy or the Institute for Molecular Physics. The program is supervised by a committee from the above units.

MUSIC PROGRAM

Professor and Chairman: Troth
Professors: Berman, Bernstein, deVermond, Gordon, Grentzer,[1] Heim, Helm, Hudson, Johnson, Moss, Taylor,[1] Traver, Ulrich
Associate Professors: Blum,[1] Garvey, Head, Meyer, Montgomery, Pennington, Schumacher, Serwer, Snapp, True, Urban, Wakefield
Assistant Professors: Davis, Gould, Kuhn, Wilson
Instructor: Steinke

[1] joint appointment with Secondary Education

The Department of Music offers specialized musical training of a highly professional nature which culminates in one of several graduate degrees. The Master of Music degree is offered in five areas of specialization: music performance, music history and literature, theory, composition, and conducting. The Doctor of Philosophy degree is offered in two areas of specialization: musicology and theory. The Doctor of Musical Arts degree is offered in literature-performance and in composition. Specializations in music education are offered in cooperation with the College of Education and culminate in Master of Arts, Master of Education, Doctor of Education, or Doctor of Philosophy degrees. Specific requirements and course offerings for those degrees are described under the program descriptions of that College.

Admission to graduate programs in music is highly selective and based upon satisfactory completion of appropriate undergraduate preparations. Evidence of established musical proficiences must be demonstrated by audition, examination in music literature and theory, and/or original musical scores. A personal interview is sometimes requested of applicants.

In addition to the requirements for the Doctor of Philosophy degree, admission to candidacy for the Doctor of Musical Arts major in composition requires placement and qualifying examinations, presentation of a lecture recital and a program of the student's own compositions. The dissertation must be the student's original composition of major proportions. Applicants for admission to candidacy in the Performance-Literature Program must satisfactorily complete placement and qualifying examinations, present a lecture recital and two full-length recitals.

In addition to the superb library holdings of the Campus itself, the adjacent city of Washington, D.C., affords graduate students in music an unexcelled opportunity for specialized research and musical exposure and development in a variety of private and public agencies, such as the Library of Congress, the Smithsonian Institution, and the John F. Kennedy Center for the Performing Arts.

MUSIC

MUSC 009. GRADUATE ENSEMBLE (1)
Required of all master's and doctoral students in applied music. Participation in departmental ensembles according to the student's major instrument, and as determined by the student's advisor.

MUSC 400. MUSIC PEDAGOGY (3)
Conference course. Prerequisite or corequisite, MUSC 418, or a more advanced course in applied music. A study of major pedagogical treatises in music, and an evaluation of pedagogical techniques, materials, and procedures.

MUSC 406, 407. APPLIED MUSIC (2, 2)
Courses for non-majors or majors electing a secondary instrument. Half-hour lesson and six practice hours per week. Prerequisite, permission of department chairman and the next lower course on the same instrument. (See Applied Music.)

MUSC 408, 409. APPLIED MUSIC (2-4, 2-4)
Courses for majors only. One-hour lesson and six practice hours per week if taken for two credits; or one-hour lesson and fifteen practice hours per week if taken for four credits. Prerequisite, permission of department chairman and the next lower course on the same instrument. (See Applied Music.)

MUSC 416, 417. APPLIED MUSIC (2, 2)
Courses for non-majors or majors electing a secondary instrument. Half-hour lesson and six practice hours per week. Prerequisite, permisison of department chairman and the next lower course on the same instrument. (See Applied Music.)

MUSC 418, 419. APPLIED MUSIC (2-4, 2-4)
Courses for majors only. One-hour lesson and six practice hours per week if taken for two credits; or one-hour lesson and fifteen practice hours per week if taken for four credits. Prerequisite, permission of department chairman and the next lower course on the same instrument. (See Applied Music.)

MUSC 430. MUSIC LITERATURE SURVEY FOR THE NON-MAJOR (3)
Prerequisite, MUSC 130 or the equivalent. Open to all students except music and music education majors. Selected compositions are studied from the standpoint of the informed listener. Choral music, opera, and art song.

MUSC 431. MUSIC LITERATURE SURVEY FOR THE NON-MAJOR (3)
Prerequisite, MUSC 130 or the equivalent. Open to all students except music and music-education majors. Selected compositions are studied from the standpoint of the informed listener. Orchestral, chamber, and keyboard music.

MUSC 432. MUSIC IN WORLD CULTURES I (3)
Folk idioms of eastern and western Europe and the Americas; American Indian musics. Historical, social, and cultural context; musical instruments; theoretical systems, form, and aesthetics; major representative musical and theatrical genres.

MUSC 433. MUSIC IN WORLD CULTURES II (3)
Art musics of Asia, including China, Japan, India, Indonesia, and Arabia-Persia. Historical, social, and cultural context; musical instruments; theoretical systems, form, and aesthetics; major representative musical and theatrical genres.

MUSC 439. COLLEGIUM MUSICUM (1)
Prerequisite, permission of the instructor. Open to undergraduates and graduates, music majors and non-majors. Procurement, edition, and performance of music not belonging to a standard repertory: early music, compositions for unusual performing media, works which demand reconstruction of their original circumstances of performance. Outcome of a semester's work may be one or more performances for the public. May be repeated for credit five times.

MUSC 440. KEYBOARD MUSIC (3)
Prerequisite, MUSIC 330, 331 or the equivalent. The history and literature of harpsichord, organ, and piano music from the Baroque period to the present. Suites, sonatas and smaller forms are studied with emphasis on changes of style and idiom.

MUSC 441. CHAMBER MUSIC (3)
Prerequisite, MUSC 330, 331, or the equivalent. The history and literature of chamber music from the early Baroque period to the present. Music for trio sonata, string quartet and quintet, and combinations of piano and strings.

MUSC 442. SYMPHONIC MUSIC (3)
Prerequisite, MUSC 330, 331, or the equivalent. The study of orchestral music from the Baroque period to the present. The concerto, symphony, overture, and other forms are examined.

MUSC 443. SOLO VOCAL LITERATURE (3)
Prerequisite, MUSC 330, 331 or the equivalent. The study of solo vocal literature from the Baroque cantata to the art song of the present. The lied, melodie, vocal chamber music, and the orchestral song are examined.

MUSC 444. CHORAL MUSIC (3)
Prerequisite, MUSC 330, 331, or the equivalent. The history and literature of choral music from the Renaissance to the present, with discussion of related topics such as Gregorian chant, vocal chamber music, etc.

MUSC 445. SURVEY OF THE OPERA (3)
Prerequisite, MUSC 330, 331, or the equivalent. A study of the music, librettos and composers of the standard operas.

MUSC 446. CONTEMPORARY MUSIC (3)
Prerequisite, MUSC 330, 331, or the equivalent. A study of music written in contemporary idioms since Debussy. Changes in form and performing media in the Twentieth Century. Electronic music and other experimental types.

MUSC 448. SPECIAL TOPICS IN MUSIC (2-6)
Prerequisite, permission of the instructor. Repeatable to a maximum of six semester hours.

MUSC 450. MUSICAL FORM (3)
Prerequisites, MUSC 250, 251. A study of the organizing principles of musical composition, their interaction in musical forms, and their functions in different styles.

MUSC 460, 461. COUNTERPOINT (2, 2)
Prerequisites, MUSC 250, 251. A course in Eighteenth-Century contrapuntal techniques. Study of devices of imitation in the invention and the chorale prelude. Original writing in the smaller contrapuntal forms.

MUSC 462. MODAL COUNTERPOINT (2)
Prerequisite, MUSC 251 or the equivalent. An introduction to the contrapuntal techniques of the Sixteenth Century: the structure of the modes, composition of modal melodies, and contrapuntal writing for two, three and four voices.

MUSC 465. CANON AND FUGUE (3)
Prerequisite, MUSC 461 or the equivalent. Composition and analysis of the canon and fugue in the styles of the Eighteenth, Nineteenth and Twentieth Centuries.

MUSC 470. HARMONIC AND CONTRAPUNTAL PRACTICES OF THE TWENTIETH CENTURY (2)
Prerequisites, MUSC 251 and 460 or the equivalents. A theoretical study of Twentieth-Century materials: scales, modes, intervals, chord structures, polyharmony, and serial and twelve-tone organization.

MUSC 479. COMPOSITION (2)
Prerequisites, MUSC 250, 251. Principles of musical composition, and their application to the smaller forms. Original writing in Nineteenth and Twentieth Century musical idioms for various media.

MUSC 479. COMPOSITION (2)
Prerequisites, MUSC 250, 251. Principles of musical composition, and their application to the smaller

forms. Original writing in Nineteenth and Twentieth Century musical idioms for various media.

MUSC 486, 487. ORCHESTRATION (2, 2)
Prerequisites, MUSC 250, 251. A study of the ranges, musical functions, and technical characteristics of the instruments, and their color possibilities in various combinations. Practical experience in orchestrating for small and large ensembles.

MUSC 490, 491. CONDUCTING (2, 2)
A laboratory course in conducting vocal and instrumental groups. Baton technique, score reading, rehearsal techniques, tone production, style and interpretation. Music of all periods will be introduced.

MUSC 495. ACOUSTICS FOR MUSICIANS (3)
Prerequisites, MUSC 251 or the equivalent, and senior or graduate standing in music. The basic physics of music, acoustics of musical instruments and music theory, physiological acoustics, and musico-architectural acoustics.

MUSC 608. CHAMBER MUSIC REPERTOIRE (1-3)
Prerequisite, graduate standing as a major in performance. A study, through performance, of diversfied chamber music for standard media. May be repeated for credit.

MUSC 609. INTERPRETATION AND REPERTOIRE (2)
Prerequisite, graduate standing in performance. (See Applied Music.)

MUSC 610. GRADUATE PERFORMANCE (4)
Prerequisite, MUSC 609. Recital course. (See Applied Music.)

MUSC 630. TEACHING THE THEORY, HISTORY, AND LITERATURE OF MUSIC (3)
Prerequisite, graduate standing and consent of instructor. A course in teaching methodology with emphasis on instruction at the college level.

MUSC 635. AMERICAN MUSIC (3)
Prerequisite, MUSC 331 and graduate standing. A lecture course in the history of American art music from colonial times to the present.

MUSC 638. ADVANCED STUDIES IN THE HISTORY OF MUSIC (3)
Prerequisite, MUSC 330, 331 and consent of instructor. A critical study of one style period (Renaissance, Baroque, etc.) will be undertaken. The course may be repeated for credit, since a different period will be chosen each time it is offered.

MUSC 639. SEMINAR IN MUSIC (3)
Prerequisite, MUSC 330, 331 and consent of instructor. The work of one major composer (Bach, Beethoven, etc.) will be studied. The course may be repeated for credit, since a different composer will be chosen each time it is offered.

MUSC 648. PRO-SEMINAR IN THE HISTORY AND LITERATURE OF MUSIC (3)
Prerequisite, MUSC 331 and graduate standing. An introduction to graduate study in the history and literature of music. Bibliography and methodology of systematic and historical musicology.

MUSC 649. SEMINAR IN MUSICOLOGY (3)
Prerequisite, MUSC 331 and graduate standing. An intensive course in one of the areas of musicology such as performance practices, history of music theory, history of notation, or ethnomusicology. Since a cycle of subjects will be studied the course may be repeated for credit.

MUSC 650. THE CONTEMPORARY IDIOM (3)
Prerequisite, MUSC 461 or equivalent, and graduate standing. Composition and analysis in the Twentieth Century styles, with emphasis on techniques of melody, harmony, and counterpoint.

MUSC 662. ADVANCED MODAL COUNTERPOINT (3)
Prerequisite, MUSC 461 or the equivalent, and graduate standing. An intensive course in the composition of music in the style of the late Renaissance. Analytical studies of the music of Palestrina, Lasso, Byrd and others.

MUSC 670. ADVANCED ANALYTICAL TECHNIQUES (3)
Prerequisite, graduate standing in music and consent of instructor. A seminar in which composer and theorist develop analytical facility in advanced Nineteenth- and Twentieth-Century music and an inclusive technique of analysis in music from the Renaissance to the present.

MUSC 671. ADVANCED ANALYTICAL TECHNIQUES (3)
Prerequisites, MUSC 670 or consent of instructor. A seminar in which composer and theorist develop analytical facility in advanced Nineteenth- and Twentieth-Century music and an inclusive technique of analysis in music from the Renaissance to the present.

MUSC 678. SEMINAR IN MUSICAL COMPOSITION (3)
Prerequisite, MUSC 479 or equivalent, and graduate standing. An advanced course in musical composition. May be repeated for credit.

MUSC 688. ADVANCED ORCHESTRATION (3)
Prerequisite, MUSC 487 or the equivalent, and graduate standing. Orchestration projects in the styles of Debussy, Ravel, Stravinsky, Schoenberg, Bartok, and others. May be repeated for credit.

MUSC 689. ADVANCED CONDUCTING (3)
Prerequisite, MUSC 491 or the equivalent. A concentrated study of the conducting techniques involved in the repertoire of all historical periods. May be repeated for credit.

MUSC 695. AESTHETICS OF MUSIC (3)
Prerequisite, MUSC 331 or the equivalent and one course in aesthetics. A consideration of the principal theories of aesthetics as they relate to music. A study of writings in the field from Pythagoras to the present.

MUSC 696. FACTORS IN MUSICAL LEARNING (3)
Prerequisite, MUSC 331 or the equivalent and at least one course in psychology. The psychology of intervals, scales, rhythms, and harmony. Musical hearing and creativity. The psychology of musical ability. The theory of functional music.

MUSC 699. SPECIAL TOPICS IN MUSIC (2-6)
Prerequisite, permission of the instructor. Repeatable to a maximum of six semester hours.

MUSC 799. MASTER'S THESIS RESEARCH (1-6)

MUSC 800, 801. ADVANCED SEMINAR IN MUSIC PEDAGOGY (3, 3)
Prerequisites, MUSC 400 or equivalent, doctoral standing and permission of instructor. A detailed study of historical and contemporary methods of pedagogy, and analysis of pedagogical problems. Sectioning by instrument. Required of all candidates for the D.M.A. Degree in literature-performance.

MUSC 805. INTERPRETATION PERFORMANCE, AND PEDAGOGY (4)
A seminar in pedagogy and the pedagogical literature for the doctoral performer, with advanced instruction at the instrument, covering appropriate compositions. Required of all candidates for the D.M.A. Degree in literature-performance. Prerequisite, doctoral standing in performance. Recital course.

MUSC 806. INTERPRETATION, PERFORMANCE, AND PEDAGOGY (4)
Prerequisite, MUSC 805. Recital course. (See Applied Music.)

MUSC 807. INTERPRETATION, PERFORMANCE AND PEDAGOGY (4)
Prerequisite, MUSC 806. Recital course. (See Applied Music.)

MUSC 830. DOCTORAL SEMINAR IN MUSIC LITERATURE (3)
Prerequisite, at least twelve hours in music history and literature. An analytical survey of the literature of music: keyboard music; vocal music; string music; wind instrument music. Required of all candidates for the D.M.A. Degree in literature-performance.

MUSC 831. DOCTORAL SEMINAR IN MUSIC LITERATURE (3)
Prerequisite, MUSC 830 or consent of instructor. An analytical survey of the literature of music: keyboard music; vocal music; string music; wind instrument music. Required of all candidates for the D.M.A. Degree in literature-performance.

MUSIC 839. DOCTORAL SEMINAR IN MUSICOLOGY (3)
Prerequisites, near completion of doctoral course work in musicology; or consent of instructor. Two semesters required of all candidates for the Ph.D. in musicology; a third semester optional. Intensive experience with the documents of musicology and the musicological synthesis.

MUSC 878. ADVANCED COMPOSITION (3)
Prerequisite, MUSC 678 or the equivalent, and permission of the instructor. Conference course in composition in the larger forms. May be repeated for credit.

MUSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

APPLIED MUSIC
A new student or one taking applied music for the first time at this university should register for MUSC 099. He will receive the proper classification at the end of his first semester in the department.
Instrument designation: each student taking an applied music course must indicate the instrument chosen by adding a suffix to the proper course number as: MUSC 609a Interpretation and Repertoire—Piano.

SUFFIX INSTRUMENT

A	Piano	H	Oboe	O	Tuba
B	Voice	I	Clarinet	P	Euphonium
C	Violin	J	Bassoon	Q	Percussion
D	Viola	K	Saxophone	R	Organ
E	Cello	L	Horn	S	Conducting
F	Bass	M	Trumpet		
G	Flute	N	Trombone		

MUSIC EDUCATION

MUED 410. METHODS AND MATERIALS FOR CLASS INSTRUMENTAL INSTRUCTION (2)
Prerequisite, previous or concurrent registration in MUSC 113-122, 213. Two one-hour laboratories and one lecture per week. Teaching techniques and rehearsal techniques for beginning and intermediate instrumental classes—winds, strings and percussion.

MUED 420. BAND AND ORCHESTRA TECHNIQUES AND ADMINISTRATION (2-3)
Prerequisites, MUSC 113-122, 213 and 491. Comprehensive study of instructional materials, rehearsal techniques, program planning, and band pageantry for the high school instrumental program. Organization, scheduling, budgeting and purchasing are included.

MUED 438. SPECIAL PROBLEMS IN THE TEACHING OF INSTRUMENTAL MUSIC (2-3)
Prerequisite, MUSC 113-122, 213 or the equivalent. A study, through practice on minor instruments, of the problems encountered in public school teaching of orchestral instruments. Literature and teaching materials, minor repairs, and adjustment of instruments are included. The course may be taken for credit three times since one of four groups of instruments: strings, woodwind, brass, or percussion, will be studied each time the course is offered.

MUED 450. MUSIC IN EARLY CHILDHOOD EDUCATION (3)
Prerequisite, MUSC 155 or equivalent. Creative experiences in songs and rhythms, correlation of music and everyday teaching with the abilities and development of each level; study of songs and materials; observation and teaching experience with each age level.

MUED 460. CREATIVE ACTIVITIES IN THE ELEMENTARY SCHOOL (2-3)
Prerequisite, music methods or teaching experience. A study of the creative approach to the development of music experiences for children in the elementary grades emphasizing contemporary music and contemporary music techniques.

MUED 462. MUSIC FOR THE ELEMENTARY SCHOOL SPECIALIST (2-3)
Prerequisite, consent of instructor. Teaching techniques and instructional materials for the music

program in the elementary schools. For the music specialist.

MUED 470. MUSIC IN SECONDARY SCHOOLS (2-3)
Prerequisite, consent of instructor. A study of the music program in the junior and senior high school with emphasis on objectives, organization of subject matter, teaching techniques and materials for general music classes.

MUED 472. METHODS AND MATERIALS IN VOCAL MUSIC FOR SECONDARY SCHOOLS (2-4)
Prerequisite, consent of instructor. A survey of repertoire and methods for teaching choral groups and voice classes. Diction, interpretation, tone production, intonation, phrasing, rehearsal techniques and style characteristics.

MUED 480. THE VOCAL MUSIC TEACHER AND SCHOOL ORGANIZATION (2)
Prerequisite, student teaching, previous or concurrent. The role of the vocal music specialist in the implementation of the supervision and administration of the music programs in the elementary and secondary schools. Open to graduate students by permission of instructor.

MUED 499. WORKSHOPS, CLINICS, INSTITUTES (2-6)
Innovative and experimental dimensions of music education will be offered to meet the needs of music teachers and music supervisors and to allow students to individualize their programs. The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached.

MUED 635. ADVANCED ORCHESTRATION AND BAND ARRANGING (3)
Prerequisite, MUSC 486 or the equivalent, or consent of instructor. A study of arranging and transcription procedures in scoring for the orchestra and band. Special attention is given to the arranging problems of the instrumental director in the public schools.

MUED 637. ADVANCED STUDY — DEVELOPING MUSICALITY THROUGH INSTRUMENTAL MUSIC (3)
Analysis of new and established methods and materials for developing musicality. The study of the curriculum for large and small ensembles, and class instruction, and its adaptation to the diverse organizations of today's schools.

MUED 662. ADVANCED STUDY — DEVELOPING MUSICALITY IN CHILDREN (3)
Analysis of new and established methods and materials including Orff and Kodaly, and their adaptation to teaching music in the diverse organizations of today's elementary schools. Emphasis on general musical experiences for all children.

MUED 672. ADVANCED STUDY — DEVELOPING MUSICALITY IN THE ADOLESCENT (3)
Analysis of new and established methods and materials for developing musicality through classes in general music, music appreciation, music in the humanities, music theory, chorus, small ensembles, and class voice.

MUED 680. ADMINISTRATION AND SUPERVISION OF MUSIC IN THE PUBLIC SCHOOLS (3)
The study of basic principles and practices of supervision and administration with emphasis on curriculum construction, scheduling, budgets, directing of in-service teaching, personnel problems, and school-community relationships.

MUED 690. RESEARCH METHODS IN MUSIC AND MUSIC EDUCATION (3)
The application of methods of research to problems in the fields of music and music education. The preparation of bibliographies and the written exposition of research projects in the area of the student's major interest.

MUED 692. FOUNDATIONS OF MUSIC EDUCATION (3)
Educational thought and its application to instruction and evaluation in music education.

MUED 698. CURRENT TRENDS IN MUSIC EDUCATION (2-8)
A survey of current and emerging philosophies, methodologies and curricula in music education and their implementation. The influence of educational and social changes and the expanding musical scene upon the music programs for children of all ages and for teacher education. The maximum number of credits that may be earned under this course symbol (within established limits of programs) toward any degree is eight semester hours. The symbol may be used two or more times until eight semester hours have been completed.

MUED 890. HISTORY OF MUSIC EDUCATION IN THE UNITED STATES (3)
Prerequisite, permission of the instructor. The study of historical development of pedagogical practices in music education, their philosophical implications and educational values.

NUCLEAR ENGINEERING PROGRAM

Professor and Acting Chairman: Munno
Professor: Duffey
Associate Professors: Almenas, Roush, Sheaks
Lecturer: Belcher

The Nuclear Engineering program has as its primary objective the maintenance and extension of the ever increasing degree of engineering sophistication. The courses and research programs strive to create an atmosphere of originality and creativity that prepares the student for the engineering leadership of tomorrow.

An individual plan of graduate study compatible with the student's interests and background is established between the student, his advisor and the department head. General areas of concentration include transport theory, reactor engineering, activation analysis, energy conversion, reactor physics, radiation engineering, reactor dynamics, radiation shielding and nuclear core design. The general nuclear engineering program is focused toward energy conversion and power engineering with the additional specialty in radiation and polymer science.

The programs leading to the M.S. and Ph.D. degrees are open to qualified students holding the B.S. degree. Full admission may be granted to students with degrees in any of the engineering and science areas from accredited programs. In some cases it may be necessary to require courses to fulfill the background. The general regulations of the Graduate School apply in reviewing applications.

The candidate for the M.S. degree has the choice of following a plan of study with thesis or without thesis. The equivalent of at least three years of full-time study beyond the B.S. degree is required for the Ph.D. degree. All students seeking graduate degrees in Nuclear Engineering must enroll in ENNU 620, 630, 655 and 440. In addition to the general rules of the Graduate School certain special degree requirements are set forth by the Department in its departmental publications.

Special facilities available for graduate study in Nuclear Engineering include the nuclear reactor, gamma and electron radiation equipment, neutron generator, and various analyzers and detectors. Activities in these areas are coordinated through the nuclear reactor facility and the Laboratory for Radiation and Polymer Science. The nuclear reactor is a 200 KW swimming pool type using enriched uranium.

The Nuclear Engineering program is administered by the Department of Chemical Engineering.

ENNU 430. RADIOISOTYPE POWER SOURCES (3)
Prerequisite, ENNU 215 or permission of instructor. Principles and theory of radioisotype power sources. Design and use of nuclear batteries and small energy conversion devices.

ENNU 435. ACTIVATION ANALYSIS (3)
Prerequisite, ENNU 215 or permission of instructor. Principles and techniques of activation analysis involving neutrons, photons and charged particles. Emphasis placed upon application of this analytical technique to solving environmental and engineering problems.

ENNU 440. NUCLEAR TECHNOLOGY LABORATORY (3)
One lecture and two laboratory periods a week. Prerequisites, MATH 240, PHYS 263. Techniques of detecting and making measurements of nuclear or high energy radiation. Radiation safety experiments. Both a sub-critical reactor and the swimming pool critical reactor are sources of radiation.

ENNU 450. NUCLEAR REACTOR ENGINEERING I (3)
Prerequisites, MATH 246 and PHYS 263 or consent of instructor. Elementary nuclear physics, reactor theory, and reactor energy transfer. Steady-state and time-dependent neutron distributions in space and energy. Conduction and convective heat transfer in nuclear reactor systems.

ENNU 455. NUCLEAR REACTOR ENGINEERING II (3)
Prerequisite, ENNU 450. General plant design considerations including radiation hazards and health physics, shielding design, nuclear power economics, radiation effects on reactor materials, and various types of nuclear reactor systems.

ENNU 468. RESEARCH (2-3)
Prerequisite, permission of the staff. Investigation of a research project under the direction of one of the staff members. Comprehensive reports are required. Repeatable to a maximum of six semester hours.

ENNU 470. INTRODUCTION TO CONTROLLED FUSION (3)
Prerequisite, consent of instructor. The principles and the current status of research to achieve controlled thermonuclear power production. Properties of ionized gases relating to confinement and heating. Concepts of practical fusion devices.

ENNU 480. REACTOR CORE DESIGN (3)
Prerequisite, ENNU 450 or consent of instructor. Design of nuclear reactor cores based on a sequence of standard computer codes. Thermal and epithermal cross sections, multi-group diffusion theory in one and two dimensions and fine structure flux calculations using transport theory.

ENNU 609. SEMINAR IN NUCLEAR ENGINEERING (1)

ENNU 620. METHODS OF ENGINEERING ANALYSIS (3)
Application of selected mathematical techniques to the analysis and solution of engineering problems; included are the applications of matrices, vectors, tensors, differential equations, integral transforms, and probability methods to such problems as unsteady heat transfer, transient phenomena in mass transfer operations, stagewise processes, chemical reactors, process control, and nuclear reactor physics.

ENNU 630. NUCLEAR REACTOR PHYSICS I (3)
Introduction to neutron physics. The theory of neutron detection instruments including the neutron chopper and solid state detectors. Elements of neutron slowing-down theory. The Boltzmann transport equation is developed together with approximations such as Pn, Sn, and Fermi age. Nuclear systems are theoretically treated utilizing the diffusion approximation, the Fermi age method and the P-3 method. Elementary temperature and time dependence.

ENNU 640. NUCLEAR REACTOR PHYSICS II (3)
Prerequisite, ENCH 320. Mathematical treatment of nuclear reactor systems. The foundations of nuclear reactor kinetics, the multigroup treatment, reflected reactor theory, heterogeneous reactors, perturbation theory. Thermalization theory and the pulse and sine-wave techniques. Introduction to variational methods.

ENNU 648. SPECIAL PROBLEMS IN NUCLEAR ENGINEERING (1-6)

ENNU 649. SELECTED TOPICS IN NUCLEAR ENGINEERING (2)
Two lectures a week. Prerequisite, permission of instructor. Topics of current interest and recent advances in the nuclear engineering field. Because of the rapid advances in the field, information on special topics of much practical importance is continually becoming available. Since the content changes, re-registration may be permitted.

ENNU 655, 656. RADIATION ENGINEERING (3, 3)
Prerequisite, permission of instructor. An analysis of such radiation applications as synthesizing chemicals, preserving foods, control of industrial processes, design of irradiation installations, e.g., cobalt 60 gamma ray sources, electronuclear machine arrangement, and chemonuclear reactors.

ENNU 667. RADIATION EFFECTS LABORATORY (3)
Prerequisite, permission of instructor. Effect of massive doses of radiation on the properties of matter for purposes other than those pointed toward nuclear power. Radiation processing, radiation-induced chemical reactions, and conversion of radiation energy; isotope power sources.

ENNU 671, 672. NUCLEAR REACTOR LABORATORY (3, 3)
Two lectures and two laboratory periods a week. Prerequisites, permission of instructor. The University of Maryland swimming pool reactor is employed in experiments on reactor start-up and operation, shielding, control, neutron flux distributions, neutron and gamma spectrum, cross section measurements.

ENNU 720. NEUTRAL PARTICLE TRANSPORT THEORY (3)
Prerequisite, ENNU 630 or permission of instructor. Transport equations for neutrons and gamma rays. Infinite space and Milne problems. Spherical harmonic and variational methods. Special methods of solving transport equations.

ENNU 730. RADIATION SHIELDING AND ENERGY DEPOSITION (3)
Prerequisite, ENNU 630 or permission of instructor. A study of the interactions of nuclear radiations with matter. Includes electron, gamma and neutron attenuation, dose calculations, chemical changes, heat generation and removal in shields.

ENNU 740. NUCLEAR REACTOR DYNAMICS (3)
Prerequisite, ENNU 640. Principles of reactor control and operation. Neutron kinetics, temperature and coolant flow effects, transfer function, stochastic processes. Stability analysis. Accident calculations. Use of analog computer or simulation and problem solving.

ENNU 761. NUCLEAR FUEL AND WASTE PROCESSING (3)
Three lectures a week. Processing of nuclear fuel and treatment of nuclear waste. Includes: processing of uranium, thorium, and other ores; chemical separation of plutonium, uranium, fission products and other elements from materials irradiated in nuclear reactors; treatment of radioactive wastes; isotopic separation of U235; and isotopic separation of heavy water and other materials.

ENNU 799. MASTER'S THESIS RESEARCH (1-6)

ENNU 840. NUCLEAR REACTOR DESIGN (3)
Prerequisite, ENNU 630 or consent of instructor. The design features of nuclear reactor systems. The preliminary design of a reactor is carried out by the student. Core design including heat transfer, control system, safety systems and shielding. Standard computer programs are utilized throughout.

ENNU 860. FAST REACTOR ENGINEERING (3)
Prerequisite, ENNU 630. Engineering and physics problems of fast reactors. Neutron economy and breeding. Transport theory based on neutronic core design. Liquid metal and gaseous coolant heat transfer. Aspects of fast reactor plant design.

ENNU 899. DOCTORAL THESIS RESEARCH (1-8)

NUTRITIONAL SCIENCES PROGRAM

Professor and Chairman: Keeney (Chemistry)
Professors: Davis, King, Mattick, Vandersall, Williams (Dairy Science); Leffel, Young (Animal Science); Holmlund, Keeney, Rollinson, Veitch (Chemistry); Prather (Food, Nutrition, and Instituttion Administration); Shaffner (Poultry Science)
Associate Professors: Lakshmanan, Sampugna (Chemistry); Ahrens, Butler, Cox, Eheart, Hopkins (Food, Nutrition, and Institution Administration); Thomas (Poultry Science)
Assistant Professors: Debarthe (Animal Science); Bull (Dairy Science); Berdanier, Eheart, Sanford (Food, Nutrition, and Institution Administration); Soares (Poultry Science)

The Graduate Program in Nutritional Sciences offers study leading to the Master of Science and the Doctor of Philosophy degrees. It is an interdepartmental program involving faculty in the Departments of Animal Science, Dairy Science, Chemistry, Food, Nutrition and Institution Administration, and Poultry Science. The student may undertake studies in any phase of nutrition.

Students interested in the program should contact the Chairman of the program for information on specific requirements.

NUSC 402. FUNDAMENTALS OF NUTRITION (3)
Three lectures per week. A study of the fundamental role of all nutrients in the body, including their digestion, absorption and metabolism. Dietary requirements and nutritional deficiency syndromes of laboratory and farm animals and man will be considered. This course will be for both graduate and undergraduate credit, with additional assignments given to the graduate students. (Soares)

NUSC 403. APPLIED ANIMAL NUTRITION (3)
Two lectures and one laboratory period per week. Prerequisites, MATH 110, NUSC 402 or permission of instructor. A critical study of those factors which influence the nutritional requirements of ruminants, swine and poultry. Practical feeding methods and procedures used in formulation of economically efficient ratios will be presented. (Vandersall)

NUSC 415. MATERNAL, INFANT AND CHILD NUTRITION (2)
Two lectures per week. Prerequisite, course in basic nutrition. Nutritional needs of the mother, infant and child and the relation of nutrition to physical and mental growth. (Butler)

NUSC 425. INTERNATIONAL NUTRITION (2)
Two lectures a week. Prerequisite, course in basic nutrition. Nutritional status of world population and

local, national, and international programs for improvement.

NUSC 435. HISTORY OF NUTRITION (2)
Two lectures per week. Prerequisite, course in basic nutrition. A study of the development of the knowledge of nutrition and its interrelationship with social and economic development.

NUSC 450. ADVANCED HUMAN NUTRITION (3)
Two lectures and one 2-hour laboratory. Prerequisites NUSC 402 or NUTR 300, CHEM 461, 462 or concurrent registration or permission of instructor. A critical study of the physiological and metabolic influences on nutrient utilization, particular emphasis on current problems in human nutrition. (Ahrens)

NUSC 460. THERAPEUTIC HUMAN NUTRITION (3)
Prerequisite, NUSC 402 or NUTR 300. Two lectures and laboratory period per week. Modification of normal adequate diet to meet human nutritional needs in pathological conditions.

NUSC 600. RECENT PROGRESS IN HUMAN NUTRITION (3)
Three lectures per week. Recent developments in the science of nutrition with emphasis on interpretation for application in health and disease. (Butler)

NUSC 601. ADVANCED RUMINANT NUTRITION (2)
Two 1-hour lectures and one 2-hour laboratory per week. Prerequisite, permission of department. Biochemical, physiological and bacteriological aspects of the nutrition of ruminants and other animals. (Vandersall)

NUSC 603. MINERAL METABOLISM (3)
Presentation of basic nutritional data on mineral metabolism with emphasis on interactions of minerals. Trace elements will be given special attention. The role of minerals in metabolic regulation is stressed. Two one-hour lectures/one two-hour discussion period. Also listed as ANSC 603. (Bull)

NUSC 604. VITAMINS (2) (Soares)

NUSC 610. READINGS IN NUTRITION (1-3)
Prerequisites, NUSC 402 or NUTR 300, CHEM 461 or consent of instructor. One lecture, one 2-hour laboratory per week. Basic concepts of animal energetics with quantitative descriptions of energy requirements and utilization.

NUSC 612. ENERGY NUTRITION (2) (Leffel)

NUSC 614. PROTEINS (2)
One lecture and one 2-hour laboratory per week. Prerequisites, NUSC 402 or NUTR 300, and CHEM 461 or consent of instructor. Advanced study of the roles of amino acids in nutrition and metabolism. Protein digestion, absorption, anabolism, catabolism and amino acid balance. (Leffel)

NUSC 620. NUTRITION FOR COMMUNITY SERVICES (3)
Three lectures per week. Application of the principles of nutrition to community problems of specific groups. Students may select problems for independent study.

NUSC 663. NUTRITION LABORATORY (2-3)
One lecture and one laboratory period per week. To acquaint students with basic techniques in nutrition research. Feeding trials with animals as well as microbiological and chemical assays are performed. Independent study of an assigned nutrition problem required for 3 credits. (Soares)

NUSC 670. INTERMEDIARY METABOLISM IN NUTRITION (3)
Three lectures per week. Prerequisites, NUSC 402 or NUTR 300, CHEM 461 or 462. The major routes of carbohydrate, fat and protein metabolism with particular emphasis on metabolic shifts and their detection and significance in nutrition. (Ahrens)

NUSC 680. HUMAN NUTRITIONAL STATUS (3)
Methods of appraisal of human nutritional status, to include dietary, biochemical and anthropometric techniques.

NUSC 698. SEMINAR IN NUTRITION (1-3)
A study in depth of a selected phase of nutrition.

NUSC 699. PROBLEMS IN NUTRITION (1-4)

NUSC 799. MASTER'S THESIS RESEARCH (1-6)
Work assigned in proportion to amount of credit. Students will be required to pursue original research in some phase of nutrition, carrying the same to completion, and reporting the results in the form of a thesis.

NUSC 898. COLLOQUIUM IN NUTRITION (1)
Oral reports on special topics or recently published research in nutrition. Distinguished scientists are invited as guest lectures. A maximum of three credits allowed for the M.S.

NUSC 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Work assigned in proportion to amount of credit. Students will be required to pursue original research in some phase of nutrition, carrying the same to completion, and reporting the results in the form of a dissertation.

ORIENTAL AND HEBREW COURSES

HEBREW

HEBR 421. THE HEBREW BIBLE (3)
Selected readings from the Torah and commentaries. The Bible in the context of the civilizations of the ancient Middle East. Comparison of the essential elements of Israelite religion and contemporary paganism. Major concepts of Jewish thought derived by traditional commentators from analysis of the Biblical text. Emphasis upon the ideas of the Bible, the human problems which it attempts to answer, and the institutions which embody those ideas. (Greenberg)

HEBR 422. THE HEBREW BIBLE (3)
Continuation of HEBR 421. (Greenberg)

HEBR 431. MODERN AND CONTEMPORARY HEBREW LITERATURE (3)
The period of the *Haskalah* (Enlightenment and the period of the *Tehiah* (Modern Revival). (Iwry)

HEBR 432. MODERN AND CONTEMPORARY HEBREW LITERATURE (3)
Readings in problems facing modern man as reflected in the writings of Agnon, Burla, Berkowitz, Mosensohn, etc. Training in literary criticism. Reading of periodicals dealing with modern literary criticism. (Iwry)

HEBR 441. STUDIES IN CLASSICAL HEBREW (3)
Linguistic peculiarities of classical Hebrew style from pre-Biblical epigraphic records to the Dead Sea Scrolls. Applies the method of literary form criticism to poetry and songs, cultic formulae, historical annals and narratives. Prerequisite, HEBR 301. (Iwry)

HEBR 442. STUDIES IN CLASSICAL HEBREW (3)
Pentateuchal source analysis, prophetic oracles, Biblical law in comparison with other ancient codes, wisdom literature, the Apocalyptic form and the Manual of Discipline of the Dead Sea Scrolls. Prerequisite, HEBR 301. (Iwry)

CHINESE

CHIN 401. READINGS FROM CHINESE HISTORY (3)
Prerequisite, CHIN 302 or equivalent. Based on anthology of historians from the Chou to the Ching Dynasties.

CHIN 402. READINGS FROM CHINESE HISTORY (3)
Prerequisite, CHIN 302 or equivalent. Based on anthology of historians from the Chou to the Ching Dynasties.

CHIN 403. CLASSICAL CHINESE I
Prerequisite, CHIN 302 or equivalent. Introductory classical Chinese using literary and historical sources in the original language.

CHIN 404. CLASSICAL CHINESE II
Prerequisite, CHIN 302 or equivalent. Further classical studies by various writers from famous ancient philosophers to prominent scholars before the New Culture Movement.

CHIN 411. CHINESE CIVILIZATION (3)
Ths course supplements GEOG 422; Cultural Geography of China and Japan. It deals with Chinese literature, art, folklore, history, government, and great men. The course is given in English.

CHIN 412. CHINESE CIVILIZATION (3)
Developments in China since 1911. The course is given in English.

CHIN 413. SURVEY OF CHINESE LITERATURE IN TRANSLATION I
The background and development of Chinese literature from the earliest philosophical writings through the poetry of the Sung Dynasty (13th century A.D.).

CHIN 414. SURVEY OF CHINESE LITERATURE IN TRANSLATION II
Yuan Dynasty drama through Ming and Ching novels and essays to the modern and revolutionary short stories, essays and poetry of the twentieth century China.

CHIN 421. CHINESE LINGUISTICS (3)
Prerequisite, CHIN 102 or equivalent.

CHIN 422. CHINESE LINGUISTICS (3)
Prerequisite, CHIN 102 or equivalent.

TAPING A NATIONAL THEATRE OF JAPAN PERFORMANCE
Department of Speech and Dramatic Art

PHILOSOPHY PROGRAM

Professor and Chairman: Gorovitz

Professors: Pasch, Perkins, Schlaretzki, Svenonius

Associate Professors: Brown, Celarier, Lesher, Martin, Svenonius

Assistant Professors: Johnson, Kress, Odell, Varnedoe

The Department of Philosophy offers graduate programs leading to the M.A. and Ph.D. degrees, with emphasis on the methodology and problems of contemporary British and American philosophy, especially in theory of knowledge, metaphysics, and ethics. Programs of study in existentialism and phenomenology are not available.

The student works closely with a committee having both advisory and tutorial functions, in arranging and pursuing a program leading to qualification for Ph.D. candidacy. There is considerable flexibility in the programs of study available to the student, the primary requirement being that he qualify in two or three areas of philosophy. In order to qualify in a given area, the student must demonstrate to his committee an adequate breadth of knowledge in the area and the ability to write philosophical essays suitable for publication.

Foreign language skills are required only insofar as demanded by the student's research. Knowledge of the language of symbolic logic is required of all students early in their course of study.

An accelerated program for exceptionally promising and well-prepared students permits early concentration on the dissertation subject.

The student has seven semesters in which to complete his qualifications for candidacy. A maximum of four years thereafter is allowed for completion of the dissertation. In the accelerated program the dissertation must be accepted no later than five years after the student enters the program.

M.A. students pursue the degree (on a thesis or nonthesis option) according to the same tutorial-advisory plan as Ph.D. students, but have different specific qualification and course requirements.

Students seeking admission should have completed, with a high grade average, at least eighteen semester hours (or the equivalent) of philosophy, including one course in logic, two courses in the history of philosophy, and two courses from the following areas: ethics, epistemology, and metaphysics. The Graduate Record Examination Aptitude Test (verbal and quantitative sections) is required. Applications must be supported by two or three letters of recommendation from previous instructors, at least one of whom is familiar with the applicant's work in philosophy. The applicant is also requested to submit an example of his written work on a philosophic topic. The letters and paper, as well as the scores, should be sent directly to the Department of Philosophy.

A brochure which describes the program in greater detail is available from the department.

PHIL 408. TOPICS IN CONTEMPORARY PHILOSOPHY (3)
Prerequisite, PHIL 320. An intensive examination of contemporary problems and issues. Source material will be selected from recent books and articles. May be repeated for credit when the topics dealt with are different.

PHIL 412. THE PHILOSOPHY OF PLATO (3)
Prerequisites, PHIL 310 and 320. A critical study of selected dialogues. (Lesher)

PHIL 414. THE PHILOSOPHY OF ARISTOTLE (3)
Prerequisites, PHIL 310 and 320. A critical study of selected portions of Aristotle's writings. (Lesher)

PHIL 416. MEDIEVAL PHILOSOPHY (3)
Prerequisites, PHIL 310 or 320. A history of philosophic thought in the West from the close of the classical period to the Renaissance. Based on readings of the Stoics, early Christian writers, Neoplatonists, later Christian writers, and Schoolmen.

PHIL 421. THE CONTINENTAL RATIONALISTS
Prerequisites, PHIL 310 and 320. A critical study of the systems of some of the major 17th and 18th Century rationalists, with special reference to Descartes, Spinoza, and Leibniz.

PHIL 422. THE BRITISH EMPIRICISTS (3)
Prerequisites, PHIL 310 and 320. A critical study of selected writings of Locke, Berkeley, and Hume. (Varnedoe)

PHIL 423. THE PHILOSOPHY OF KANT (3)
Prerequisites, PHIL 310 and 320. A critical study of selected portions of Kant's writings.

PHIL 428. TOPICS IN THE HISTORY OF PHILOSOPHY (3)
Prerequisites, PHIL 310 and 320, or consent of instructor. May be repeated for credit when the topics dealt with are different.

PHIL 440. ETHICAL THEORY (3)
Prerequisite, PHIL 140. Contemporary problems having to do with the meaning of the principal concepts of ethics and with the nature of moral reasoning (Schlaretzki)

PHIL 445. POLITICAL AND SOCIAL PHILOSOPHY (3)
Prerequisite: PHIL 140 or 345. A systematic treatment of the main philosophical issues encountered in the analysis and evaluation of social (especially political) institutions. (Johnson, Schlaretzki)

PHIL 447. PHILOSOPHY OF LAW (3)
Prerequisite, one course in philosophy. Examination of fundamental concepts related to law, e.g., legal system, law and morality, justice, legal reasoning, responsibility. (Johnson)

PHIL 455. PHILOSOPHY OF THE SOCIAL SCIENCES (3)
Prerequisites, six hours in social science or consent of instructor. A discusion of several of the following topics: The nature of laws and explanation in the social sciences; the relation of the social sciences to mathematics, logic, and the natural sciences; the role of value judgments in the social

sciences; the relation of social science to social policy; problems of methodology.

PHIL 457. PHILOSOPHY OF HISTORY (3)
An examination of the nature of historical knowledge and historical explanation, and of theories of the meaning of world history. (Martin)

PHIL 458. TOPICS IN THE PHILOSOPHY OF SCIENCE (3)
Prerequisite, PHIL 250 or consent of instructor. Detailed examination of some basic issues in the methodology and conceptual structure of scientific inquiry. To be investigated are such topics as confirmation theory, structure and function of scientific theories, scientific explanation, concept formation, and theoretical reduction. (Suppe)

PHIL 461. THEORY OF MEANING (3)
Prerequisites, PHIL 170 or 271, and 320. A study of theories about the meaning of linguistic expressions, including the vertification theory and the theory of meaning as use. Among topics to be considered are naming, referring, synonymy, intension and extension, and ontological commitment. Such writers as Mill, Frege, Russell, Lewis, Carnap, Wittgenstein, Austin, and Quine will be discussed. (Kress, Odell)

PHIL 462. THEORY OF KNOWLEDGE (3)
Prerequisites, PHIL 310 and 320. PHIL 271 is recommended. The origin, nature, and validity of knowledge considered in terms of some philosophic problems about perceiving and thinking, knowledge and belief, thought and language, truth and confirmation. (Brown, Kress, Odell, Pasch)

PHIL 464. METAPHYSICS (3)
Prerequisites, PHIL 310 and 320. PHIL 271 is recommended. A study of some central metaphysical concepts (such as substance, relation, causality, and time) and of the nature of metaphysical thinking. (Pasch)

PHIL 466. PHILOSOPHY OF MIND (3)
Prerequisite, PHIL 320. An inquiry into the nature of mind through the analysis of such concepts as consciousness, perception, understanding, imagination, emotion, invention, and action. (Perkins)

PHIL 471. SYMBOLIC LOGIC II (3)
Prerequisite, PHIL 271 or consent of instructor. Axiomatic development of the propositional calculus and the first-order functional calculus, including the deduction theorem, independence of axioms, consistency, and completeness. (Svenonius)

PHIL 474. INDUCTION AND PROBABILITY (3)
Prerequisite, consent of instructor. A study of inferential forms, with emphasis on the logical structure underlying such inductive procedures as estimating and hypothesis-testing. Decision-theoretic rules relating to induction will be considered, as well as classic theories of probability and induction.

PHIL 478. TOPICS IN SYMBOLIC LOGIC (3)
Prerequisite, PHIL 471. May be repeated for credit when the topics dealt with are different. (Svenonius)

PHIL 498. TOPICAL INVESTIGATIONS (1-3)

PHIL 499. TOPICAL INVESTIGATIONS (1-3)

PHIL 688. SELECTED PROBLEMS IN PHILOSOPHY (1-3)
Prerequisite, consent of instructor.

PHIL 788. RESEARCH IN PHILOSOPHY (1-6)

PHIL 799. MASTER'S THESIS RESEARCH (1-6)

PHIL 808. SEMINAR IN THE PROBLEMS OF PHILOSOPHY (3)
Prerequisite, consent of instructor.

PHIL 828. SEMINAR IN THE HISTORY OF PHILOSOPHY (3)
Prerequisite, consent of instructor.

PHIL 838. SEMINAR IN ESTHETICS (3)
Prerequisite, consent of instructor.

PHIL 848. SEMINAR IN ETHICS (3)
Prerequisite, consent of instructor.

PHIL 868. SEMINAR IN METAPHYSICS (3)
Prerequisite, consent of instructor.

PHIL 869. SEMINAR IN THE THEORY OF KNOWLEDGE (3)
Prerequisite, consent of instructor.

PHIL 899. DOCTORAL DISSERTATION RESEARCH (1-8)

PHYSICAL EDUCATION PROGRAM

Professor and Chairman: Husman

Professors: Clarke, Eyler, Humphrey, Kramer

Associate Professors: Church, Dotson, Hult, Ingram, Kelley, Love,[1] Santa Maria, Steel

Assistant Professors: Fringer, Johnson, Tyler, VanderVelden, Wrenn [1]

[1] joint appointment with Secondary Education

The graduate student majoring in Physical Education may pursue the degrees of Master of Arts, Doctor of Education, or Doctor of Philosophy. The two major objectives of these programs are: (1) to study the discipline of physical education, that is, to study the effects of physical activity on man from a historical, physiological, kinesiological, philosophical, social and psychological point of view; (2) to acquaint the student with the pedagogy of physical education, to improve the quality of teaching, and to offer the student ways to improve the administration and supervision of programs in schools and colleges.

A student may pursue study in exercise physiology, kinesiology, motor learning, sport sociology, sport history and philosophy, or elementary or secondary curriculum-supervision-administration.

In addition to the minimum requirements of The Graduate School, adequate preparation in physical education from an accredited institution is required. This preparation should include, but not be limited to, such upper division requirements as kinesiology, exercise physiology, measurement and evaluation, history and philosophy of physical education. In addition, a background in mathematics, physical and/or biological sciences, and the behavioral sciences is required.

All students are required to take a preliminary examination, the Graduate Diagnostic Examination, during the first regular semester or summer session of a student's enrollment. This examination includes six sections: tests and measurement, kinesiology, physiology of exercise, adapted physical education, psychology of learning and history of physical education. Competency must be attained in each of these areas by course work, independent study, or reexamination.

All Master of Arts students are required to take courses in methods of research and in statistics and to write and successfully defend a thesis.

The department maintains a modern research laboratory for physical education, including, but not limited to, cinematographic analysis, cardio-vascular measurement, strength and other motor fitness assessment, analysis of motion, and motor learning research. The department also possesses several of the most modern computers and a direct teletype link to the University Computer Science Center.

PHED 400. KINESIOLOGY (4)
Three lectures and two laboratory hours a week. Prerequisites, ZOOL 101, 201, and 202 or the equivalent. The study of human movement and the physical and physiological principles upon which it depends. Body mechanics, posture, motor efficiency, sports, the performance of atypical individuals, and the influence of growth and development upon motor performance are studied.

PHED 420. PHYSICAL EDUCATION FOR THE ELEMENTARY SCHOOL (3)
Orientation of the general elementary teacher to physical education. Principles and practices in elementary physical education are discussed and a variety of appropriate activities are considered.

PHED 450. THE PSYCHOLOGY OF SPORTS (3)
Three hours a week. An exploration of the personality factors, including, but not limited to motivation, aggression and emotion, as they affect sports participation and motor skill performance.

PHED 455. PHYSICAL FITNESS OF THE INDIVIDUAL (3)
A study of the major physical fitness problems confronting the adult in modern society. Consideration is given to the scientific appraisal, development, and maintenance of fitness at all age levels. Such problems as obesity, weight reduction, chronic fatigue, posture, and special exercise programs are explored. Open to persons outside the profession of physical education.

PHED 460. PHYSIOLOGY OF EXERCISE (3)
Two lectures and two laboratory hours a week. Prerequisites, ZOOL 101, 201 and 202; PHED 400 or equivalent. A study of the physiology of exercise, including concepts of work, muscular contraction, energy transformation, metabolism, oxygen debt, and nutrition and athletic performance. Emphasis is placed on cardiovascular and respiratory function in relation to physical activity and training.

PHED 480. MEASUREMENT IN PHYSICAL EDUCATION (3)
Two lectures and two laboratory periods a week. Prerequisite, MATH 105 or 110. A study of the principles and techniques of educational measurement as applied to teaching of physical education; study of the functions and techniques of measurement in the evaluation of student progress toward the objectives of physical education and in the evaluation of the effectiveness of teaching.

PHED 485. MOTOR LEARNING AND SKILLED PERFORMANCE (3)
Prerequisites, PHED 480 and PSYC 100. A study of the research dealing with motor learning and motor performance. Major topics discussed are scientific methodology, individual differences, specificity, proprioceptive control of movement, motivation, timing, transfer, and retention.

PHED 487. PHYSICAL EDUCATION AND SPORT IN CONTEMPORARY CULTURES (3)
Three lectures a week. Prerequisite, SOCY 100 or equivalent. A study of the cultural impact of physical education activities in the United States and selected countries. Individual research on selected topics is required.

PHED 489. FIELD LABORATORY PROJECTS AND WORKSHOP (1-6)
Workshops and research projects in special areas of knowledge not covered by regularly structured courses. *NOTE:* The maximum total number of credits that may be earned toward any degree in Physical Education is six.

PHED 490. ORGANIZATION AND ADMINISTRATION OF PHYSICAL EDUCATION (3)
The application of the principles of administration and supervision to physical education. Students are normally enrolled during the student teaching semester.

PHED 491. THE CURRICULUM IN ELEMENTARY SCHOOL PHYSICAL EDUCATION (3)
Techniques, planning and construction are considered from a standpoint of valid criteria for the selection of content in elementary school physical education. Desirable features of cooperative curriculum planning in providing for learning experiences will be presented and discussed.

PHED 493. HISTORY AND PHILOSOPHY OF SPORT AND PHYSICAL EDUCATION (3)
History and philosophical implications of sport and physical education through Ancient, Medieval, and contemporary periods in Western civilization.

PHED 495. ORGANIZATION AND ADMINISTRATION OF ELEMENTARY SCHOOL PHYSICAL EDUCATION (3)
Prerequisite, PHED 420. Studies the procedures basic to satisfactory organization of all phases of the elementary school physical education program. Emphasis is placed on the organizational and administrative factors necessary for the successful operation of the program in various types of elementary schools.

PHED 496. QUANTITATIVE METHODS (3)
Statistical techniques most frequently used in research pertaining to physical education. Effort is made to provide the student with the necessary

skills, and to acquaint him with the interpretations and applications of these techniques.

PHED 600. SEMINAR IN PHYSICAL EDUCATION (1)

PHED 602. STATUS AND TRENDS IN ELEMENTARY SCHOOL PHYSICAL EDUCATION (3)
Analyzes the current status and implications for future trends in physical education at the elementary school level. Open to experienced persons in all phases of education.

PHED 604. PHYSICAL EDUCATION AND THE DEVELOPMENT OF THE CHILD (3)
Analyzes the place of physical education in meeting the growth and developmental needs of children of elementary school age.

PHED 606. PERCEPTUAL-MOTOR DEVELOPMENT THROUGH PHYSICAL EDUCATION (3)
A study of the development of perceptual-motor skills through directed physical activities. An investigation of the growth and development of perceptual-motor programs. Analysis of common factors and differences between selected programs and philosophies. Evaluation in perceptual-motor development.

PHED 610. METHODS AND TECHNIQUES OF RESEARCH (3)
Studies methods and techniques of research used in physical education; an analysis of examples of their use and practice in their application to problems of interest to the student.

PHED 612. RESEARCH LITERATURE (3)
Studies the research literature of physical education, plus research in one specific problem.

PHED 615. PRINCIPLES AND TECHNIQUES OF EVALUATION (3)
Prerequisite, an introductory course in measurement or permission of the instructor. A study of currently used means of evaluating the performances of students and the effectiveness of programs of physical education in schools and colleges. Specific problems concerning evaluation, brought in by members of the class, will be analyzed.

PHED 620. ANALYSIS OF CONTEMPORARY ATHLETICS (3)
Studies current problems, practices, and national issues of permanent importance to the conduct of athletic competition in a democracy.

PHED 630. SOCIOLOGY OF SPORT IN CONTEMPORARY PERSPECTIVE (3)
Studies social organization and the role of individuals and groups in sport situations; the interrelationship of sport with traditional social institutions; sport as a sub-system and its structure; and sport and social problems.

PHED 640. SUPERVISORY TECHNIQUES IN PHYSICAL EDUCATION (3)
Studies current concepts, principles and techniques of supervision and of their application; observation of available supervising programs, including visits with local supervisors; and practice in the use of selected techniques.

PHED 642. ADMINISTRATIVE DIRECTION OF PHYSICAL EDUCATION (3)
Analyzes administrative problems in the light of sound educational practice. Students concentrate their efforts upon their own on-the-job administrative problems and contribute to the solution of other class members' problems.

PHED 644. CURRICULUM CONSTRUCTION IN PHYSICAL EDUCATION (3)
Studies the principles underlying curriculum construction in physical education and the practical applications of these principles to the construction of a curriculum.

PHED 650. MENTAL AND EMOTIONAL ASPECTS OF SPORTS AND RECREATION (3)
Prerequisites, Psychology and/or Human Development. An exploration of psychological aspects of physical education, sports and recreation, including personality dynamics in relation to exercise and sports. A study is made of the psychological factors in athletic performance and coaching.

PHED 660. PHILOSOPHY OF PHYSICAL EDUCATION (3)
Studies five important philosophical disciplines and their impact on modern physical education and sport; and an exploration of the valid philosophical approaches and processes to formulation of a personal philosophy of physical education.

PHED 662. HISTORY OF SPORT IN WESTERN CULTURE (3)
Prerequisites, PHED 493 or equivalent and 12 hours in upper division level courses involving Western culture. A history of sport of the early and Medieval periods.

PHED 663. HISTORY OF SPORT IN WESTERN CULTURE (3)
Prerequisites, PHED 493 or equivalent and 12 hours in upper division level courses involving Western culture. A history of sport of the Renaissance and modern periods.

PHED 688. SEMINAR IN MOTOR LEARNING AND PERFORMANCE (3)
Prerequisites, PHED 485 and 496. Discussion of research dealing with advanced topics in motor learning and skilled performance. Recent developments concerning individual differences, refractoriness, anticipation and timing, transfer, retention, and work inhibition are emphasized. May be repeated for a total of 6 hours.

PHED 689. SPECIAL PROBLEMS IN PHYSICAL EDUCATION (1-6)
Master's or Doctoral candidates who desire to pursue special research problems under the direction of their advisor may register for 1-6 hours of credit under this number.

PHED 690. SCIENTIFIC BASES OF EXERCISE (3)
Prerequisites, Anatomy, Physiology, PHED 400, 460, or equivalent. A critical analysis of the role of physical exercise in modern society with attention given to such topics as the need for physical exercise, its chronic effects, the role of exercise in attaining good physical condition and fitness, factors deter-

mining championship performances, and physical fatigue.

PHED 775. ADVANCED ANALYSIS OF HUMAN MOTION (3)
Prerequisites, PHED 400, 460, college algebra or equivalent or by permission of instructor. A research oriented kinesiological analysis of human movement as it relates to sports and the activities of daily living. The analysis is accomplished by means of various measurement procedures including cinematography, electronic timing devices and similar instruments.

PHED 789. ADVANCED SEMINAR (1-3)
Studies the current problems and trends in selected fields of physical education.

PHED 799. MASTER'S THESIS RESEARCH (1-6)

PHED 899. DOCTORAL DISSERTATION RESEARCH (1-8)

PHYSICS PROGRAM

Professor and Chairman: Laster
Professors: Alley, Banerjee, Bhagat, Brill, Day, Davidson, Dorfman,[3] Ferrell, Friedman, Glasser,[1] Glover, Greenberg, Griem, Griffin, Hayward, Holmgren, Hornyak, Koch, Krall, Levinson, MacDonald, Marion, McDonald, Misner, Myers, Oneda, Pati, Prange, Pugh, Rado, Reiser,[2] Slawsky, Snow, Sucher, Trivelpiece, Wall, Weber, Yodh, G. T. Zorn.
Associate Professors: Anderson, Bardasis, Beall, Bennett, Currie, De Silva, Dixon, Dragt, Earl, Falk, Fivel, Glick, Gloeckler, Kacser, H. Kim,[2] Y. S. Kim, Korenman, Minkiewicz, Roos, Roush,[5] Steinberg, Stephenson, Woo, B. S. Zorn
Assistant Professors: Brayshaw, C. Y. Chang, Chant, Connors, Drew, Ellsworth, Glosser, Greene, Gowdy, Hill, Korenman, Layman,[4] Martin, Mead, O'Gallagher, Pechacek, Redish, Richard

[1] joint appointment with Computer Science
[2] joint appointment with Electrical Engineering
[3] joint appointment with Institute for Fluid Dynamics and Applied Mathematics
[4] joint appointment with Secondary Education
[5] joint appointment with Chemical Engineering

Because of the large number of qualified applicants, the Department of Physics and Astronomy has had to restrict formal admission to The Graduate School to those who have shown particularly outstanding work in their undergraduate records, or who have already done satisfactory work in key senior-level courses at the University of Maryland. Students who have less outstanding records but who, because of exceptional circumstances, show special promise may be given provisional admission, with regular admission pending the satisfactory completion of existing deficiencies. Each student so admitted will be informed by an assigned departmental advisor what background he is lacking, and what he must accomplish to achieve regular admission. The University of Maryland hopes in this way to offer an opportunity for advanced study in Physics and Astronomy to all qualified students.

Entering graduate students are normally expected to have strong backgrounds in physics, including courses in the intermediate level in mechanics, electricity and magnetism, thermodynamics, physical optics, and modern physics. A student with deficiences in one or more of these areas may be admitted, but will be expected to remedy such deficiencies as soon as possible.

The department offers both thesis and non-thesis M.S. programs. The departmental requirements for the non-thesis option include at least four courses of the general physics sequence, PHYS 601, 602, 604, 606, 622 and 623, plus the graduate lab, PHYS 621, unless specifically exempted; a research paper as evidence of ability to organize and present a scholarly report on contemporary research; the passing at an appropriate level of one section of the Ph.D. qualifying exam; and the passing of a final oral examination.

The Department of Physics and Astronomy has active programs in several areas of current research. Those in astronomy are listed under the heading of Astronomy. Those in the physics program include: astrophysics, atomic physics, chemical physics, elementary particle theory, fluid dynamics, general relativity, high energy physics, many-body theory, molecular physics, nuclear physics, particle accelerator research, plasma physics, quantum electronics and optics, quantum field theory, solid state physics, space physics, and statistical mechanics.

The requirements for the Master of Science degree with thesis include at least four courses of the general physics sequence plus, for students presenting a theoretical thesis, the graduate laboratory unless specially exempted; and the passing of an oral examination including a defense of thesis.

The requirements for the Ph.D. in Physics are set in general terms to allow the individual student as much freedom as possible in preparing a course of study suited to individual needs. These requirements are: competence in basic physics indicated by satisfactory performance on a Qualifying Examination and in the Graduate Laboratory; advanced course study outside the student's field of specialization consisting of at least two courses (6 credits) in physics at the 700 or 800 level and two courses (6 credits) recognized for graduate credit given outside the physics program (this may include astronomy); and research competence through active participation in at least two hours of seminar, 12 hours of thesis research and the presentation and defense of an original dissertation.

The University of Maryland is located within the metropolitan area of Washington, D.C., where it enjoys the proximity of a large number of outstanding institutions such as NASA's Goddard Space Flight Center, the Naval Research Laboratory, the Naval Ordnance Laboratory, the National Bureau of Standards, the Johns Hopkins Applied Physics Laboratory, the Atomic Energy Commission, the National Institutes of Health, the Library of Congress, and other Federal institutions. The department has close ties with certain research groups at some of these institutions.

The Department of Physics and Astronomy offers off-campus courses at convenient times and places so as to accommodate the greatest number of students. In order to facilitate graduate study in the Washington area, the department has part-time professors in certain government laboratories. All Master of Science candidates must take at least three

credits of their graduate work on the College Park campus; for the Doctor of Philosophy degree, students must complete on the College Park campus at least 18 credits. Normally, students will complete a much greater proportion of their graduate study on the College Park campus. At government agencies where there is no part-time professor, employees desiring to do graduate work in physics should contact a member of the graduate faculty in the department.

For complete information, students should write to the Graduate Entrance Committee, Department of Physics and Astronomy.

PHYS 400. BASIC CONCEPTS OF PHYSICS I (3)
Prerequisite, junior standing. A primarily descriptive course in two semesters, intended mainly for those students in the liberal arts who have not had any other course in physics. This course does not serve as a prerequisite or substitute for other physics courses. The main emphasis is on the concepts of physics, their evolution and their relation to other branches of human endeavor.

PHYS 401. BASIC CONCEPTS OF PHYSICS II (3)
Prerequisite, PHYS 400 or consent of instructor.

PHYS 404. INTERMEDIATE THEORETICAL MECHANICS (3)
Prerequisite, PHYS 271 and 321; or 284 or 263; MATH 241 previously or concurrently. Fundamentals and selected advanced topics of physical mechanics. Vector differential calculus will be used. For students starting physics without calculus, this course serves as part of the series of PHYS 271, 321, 404, 405, to provide terminal courses in general physics for physical science majors.

PHYS 405. INTERMEDIATE THEORETICAL ELECTRICITY AND MAGNETISM (3)
Prerequisite, PHYS 284, or 263 or 321; MATH 241. After MATH 241 this course may be taken concurrently with PHYS 404. Intermediate electricity and magnetism and electromagnetic waves (optics). Vector differential calculus is used throughout.

PHYS 406. OPTICS (3)
Prerequisite, PHYS 263 or 284; and MATH 240; or consent of the instructor. Geometrical optics, optical instruments, wave motion, interference and diffraction, and other phenomena in physical optics.

PHYS 407. SOUND (3)
(Will be given only with sufficient demand.) Prerequisite, PHYS 122, 142 or 263, MATH 240 is to be taken concurrently.

PHYS 410. ELEMENTS OF THEORETICAL PHYSICS —MECHANICS (4)
Prerequisites, PHYS 263, 284, 404 and 405; also MATH 241; or consent of instructor. A study of the theoretical foundations of mechanics, with extensive application of the methods. Also various mathematical tools of theoretical physics.

PHYS 411. ELEMENTS OF THEORETICAL PHYSICS —ELECTRICITY AND MAGNETISM (4)
Prerequisite, PHYS 410 or consent of instructor. A study of the foundations of electromagnetic theory, with extensive application of the methods. Thorough treatment of wave properties of solutions of Maxwell's equations.

PHYS 412. KINETIC THEORY OF GASES (3)
Prerequisites, PHYS 404 and 405 or PHYS 410 and MATH 240 or equivalent. Dynamics of gas particles, Maxwell-Boltzmann distribution, diffusion, Brownian motion, etc.

PHYS 414. INTRODUCTION TO THERMODYNAMICS AND STATISTICAL MECHANICS (3)
Prerequisites, MATH 240, PHYS 284 or 404 or consent of the instructor. Introduction of basic concepts in thermodynamics and statistical mechanics.

PHYS 420. MODERN PHYSICS FOR ENGINEERS (3)
Prerequisites, PHYS 263 or 284 or 404 and 405; MATH 241 or consent of instructor. A survey of atomic and nuclear phenomena and the main trends in modern physics. This course is appropriate for students in engineering and other physical sciences. It should not be taken in addition to PHYS 421.

PHYS 421. INTRODUCTION TO MODERN PHYSICS (3)
Prerequisites, PHYS 284 or equivalent; MATH 241 including some knowledge of ordinary differential equations. Introductory discussion of special relativity, origin of quantum theory, Bohr atom, wave mechanics, atomic structure, and optical spectra.

PHYS 422. MODERN PHYSICS (3)
Prerequisite, PHYS 421. This course uses the basic ideas of quantum mechanics and special relativity to discuss the characteristics of many diverse subjects including complex atoms, molecules, solids, nuclei and elementary particles.

PHYS 423. ELEMENTARY QUANTUM PHYSICS (3)
Prerequisites, PHYS 420 or 421; MATH 246; and a level of mathematical sophistication equivalent to that of a student who has taken PHYS 410 and 411, or ENEE 380 and 382. The quantum theory is presented in a rigorous way including the concepts of operators, measurements and angular momentum. These concepts together with the Schroedinger Equation are then applied to some basic problems in atomic and molecular physics.

PHYS 429. ATOMIC AND NUCLEAR PHYSICS LABORATORY (3)
Prerequisites, PHYS 365 and consent of instructor. Classical experiments in atomic physics and more sophisticated experiments in current techniques in nuclear physics.

PHYS 431. PROPERTIES OF MATTER (3)
Prerequisite, PHYS 404 and 405 or 410, 420 or 421. Introduction to solid state physics. Electromagnetic, thermal, and elastic properties of metals, semiconductors and insulators.

PHYS 441. NUCLEAR PHYSICS (3)
Prerequisite, PHYS 420, or 421. An introduction to nuclear physics at the prequantum-mechanics level. Properties of nuclei; radioactivity; nuclear systematics; nuclear moments; the shell model, interaction of charged particles and gamma rays with matter; nuclear detectors; accelerators; nuclear reactions; beta decay; high energy phenomena.

PHYS 443. NEUTRON REACTOR PHYSICS (3)
Prerequisite, PHYS 371 or 421 or consent of instructor. Various related topics in neutron reactor physics.

PHYS 451. INTRODUCTION TO ELEMENTARY PARTICLES (3)
Prerequisite, PHYS 422 or consent of instructor. Properties of elementary particles. Production and detection of particles, relativistic kinematics, invariance principles and conservation laws.

PHYS 461. INTRODUCTION TO FLUID DYNAMICS (3)
Prerequisites, PHYS 404 and MATH 240, Kinematics of fluid flow, properties of incompressible fluids, complex variable methods of analysis, wave motions.

PHYS 463. INTRODUCTION TO PLASMA PHYSICS (3)
Prerequisite, PHYS 404 or 410. Orbit theory, magnetohydrodynamics, plasma heating and stability, waves and transport processes.

PHYS 465. MODERN OPTICS (3)
Prerequisite, PHYS 406 and 420 or 421, and 411 or consent of the instructor. Designed for students with a background in fundamental optics, this course deals with topics in modern optics such as coherence, holography, principles of laser action, electron optics, and non-linear optics.

PHYS 471. INTRODUCTION TO ATMOSPHERIC AND SPACE PHYSICS (3)
Prerequisite, PHYS 263 or 284. Motions of charged particles in magnetic fields, aspects of plasma physics related to cosmic rays and radiation belts, atomic phenomena in the atmosphere, thermodynamics and dynamics of the atmosphere. Students who have not done A or B work in their previous physics courses would be well advised to take another upper level physics course before proceeding to this course.

PHYS 483. INTRODUCTION TO BIOPHYSICS (3)
Prerequisite, Senior level standing in physics, or consent of the instructor (open to students outside physics). A topical introduction to problems in biophysics: cell structure; intermolecular forces; photosynthesis; control processes including enzyme function, allosterism, cooperative transitions in biopolymers and the regulation of protein synthesis; biological rhythms; membranes including bioelectric potentials and the Hodgkin-Huxley equations; muscle contraction.

PHYS 485. ELECTRONIC CIRCUITS (4)
Three hours of lecture and two of laboratory per week. Prerequisites, PHYS 365 and concurrent enrollment in PHYS 405 or 411. Theory of semi-conductor and vacuum tube circuits. Application in experimental physics.

PHYS 487. PARTICLE ACCELERATORS, PHYSICAL AND ENGINEERING PRINCIPLES (3)
Prerequisites, PHYS 142, 284 or PHYS 263. Sources of charged particles, methods of acceleration and focusing of electron and ion beams in electromagnetic fields; electrostatic accelerators; constant-gradient cyclotrons and synchrotrons; betatrons and microtrons; the alternating-gradient and sector-focusing principles; isochronous cyclotrons and alternating-gradient synchrotrons: linear accelerators. This course is also listed as ENEE 487.

PHYS 499. SPECIAL PROBLEMS IN PHYSICS (1-6)
Prerequisite, major in physics and consent of advisor. Research or special study. Credit according to work done.

PHYS 601. THEORETICAL DYNAMICS (3)
Prerequisite, PHYS 410 or equivalent. Lagrangian and Hamiltonian mechanics; two-body central force problem, rigid body motion, small oscillations, continuous systems.

PHYS 602. STATISTICAL PHYSICS (3)
Prerequisite, PHYS 410 or equivalent. Statistical mechanics, thermodynamics, kinetic theory.

PHYS 604. METHODS OF MATHEMATICAL PHYSICS (3)
Prerequisite, advanced calculus, PHYS 410 and 411, or equivalent. Ordinary and partial differential equations of physics, boundary value problems, Fourier series, Green's functions, complex variables and contour integration.

PHYS 606. ELECTRODYNAMICS (4)
Prerequisite, PHYS 604 or equivalent. Classical electromagnetic theory, electro- and magnetostatics, Maxwell Equations, waves and radiation, special relativity.

PHYS 621. GRADUATE LABORATORY (3)
Six hours of laboratory per week. Design and performance of advanced experiments in modern and classical physics.

PHYS 622. INTRODUCTION TO QUANTUM MECHANICS I (4)
Prerequisite, an outstanding undergraduate background in physics. A study of the Schroedinger Equation, matrix formulations of quantum mechanics, approximation methods, scattering, etc., and applications to solid state, atomic, and nuclear physics.

PHYS 623. INTRODUCTION TO QUANTUM MECHANICS II (3)
Prerequisite, an outstanding undergraduate background in physics. A study of the Schroedinger Equation, matrix formulations of quantum mechanics, approximation methods, scattering theory, etc., and applications to solid state, atomic, and nuclear physics. Continuation of PHYS 622.

PHYS 624. ADVANCED QUANTUM MECHANICS (3)
Prerequisite, PHYS 623. Relativistic wave equations, second quantization in many body problems and relativistic wave equations, Feynman-Dyson Perturbation Theory, applications to many body problems, application to quantum electrodynamics, elements of renormalization.

PHYS 686. CHARGED PARTICLE DYNAMICS, ELECTRON AND ION BEAMS (3)
Prerequisites, PHYS 410, 411 or PHYS 271, 321 or consent of instructor. Three hours per week. General principles of single-particle dynamics; analyti-

cal and practical methods of mapping electric and magnetic fields; equations of motion and special solutions; Liouville's Theorem; electron optics; space charge effects in high current beams; design principles of special electron and ion beam devices. This course is also listed as ENEE 686.

PHYS 703. THERODYNAMICS (3)
Prerequisite, PHYS 602. The first and second laws of thermodynamics are examined and applied to homogeneous and non-homogeneous systems, calculations of properties of matter, the derivation of equilibrium conditions and phase transitions, the theory of irreversible processes.

PHYS 704. STATISTICAL MECHANICS (3)
Prerequisites, PHYS 422 and 602. A study of the determination of microscopic behavior of matter from microscopic models. Microcanonical, canonical, and grand canonical models. Applications to solid state physics and the study of gases.

PHYS 708. SEMINAR IN TEACHING COLLEGE PHYSICS (1)

PHYS 709. SEMINAR IN GENERAL PHYSICS (1)

PHYS 711. SYMMETRY PROBLEMS IN PHYSICS (3)
Prerequisite, PHYS 623. A study of general methods of classification of physical systems by their symmetries and invariance properties, especially in quantum field theory applications.

PHYS 718, 719. SEMINAR IN GENERAL PHYSICS (1, 1)

PHYS 721. THEORY OF ATOMIC SPECTRA (3)
Prerequisite, PHYS 622. A study of atomic spectra and structure: one and two electron spectra, fine and hyperfine structure, line strengths, line widths, etc.

PHYS 722. THEORY OF MOLECULAR SPECTRA (3)
Prerequisite, PHYS 721. The structure and properties of molecules as revealed by rotational, vibrational and electronic spectra.

PHYS 723. MOLECULAR PHYSICS I (2)
Prerequisite, PHYS 623. The fundamentals of the interpretation of the spectra of simple molecules with particular attention to quantitative considerations. Emphasis on topics generally regarded as falling outside the domain of molecular structure, notably the measurement and analysis of molecular spectroscopic line intensities.

PHYS 724. MOLECULAR PHYSICS II (2)
See PHYS 723 for description.

PHYS 728. SEMINAR IN ATOMIC AND MOLECULAR PHYSICS (1)

PHYS 729. SEMINAR IN GENERAL QUANTUM MECHANICS AND QUANTUM ELECTRONICS (1)

PHYS 731. SOLID STATE PHYSICS (3)
A variety of topics such as crystal structure, mechanical, thermal, electrical, and magnetic properties of solids, band structure, the Fermi-surface, and superconductivity will be treated. Although the emphasis will be on the phenomena, the methods of quantum mechanics are freely employed in this description.

PHYS 738. SEMINAR IN EXPERIMENTAL SOLID STATE PHYSICS (1)

PHYS 739. SEMINAR IN THEORETICAL SOLID STATE PHYSICS (1)

PHYS 741. NUCLEAR STRUCTURE PHYSICS I (3)
Prerequisite, PHYS 441 or equivalent; co-requisite, PHYS 622-623 or consent of instructor. Nuclear structure and nuclear reactions. Two-body scatterings; nucleon-nucleon forces and the deuteron. Neutron scattering; the optical model. Resonance reactions, phase-shift analysis, positions and properties of energy levels; the shell model. Direct reactions. Electromagnetic transitions. Photoreactions. The design of experiments; the extraction of parameters from experimental data and the comparison with nuclear models.

PHYS 742. NUCLEAR STRUCTURE PHYSICS II (3)
See PHYS 741 for description.

PHYS 748. SEMINAR IN EXPERIMENTAL NUCLEAR PHYSICS (1)

PHYS 749. SEMINAR IN THEORETICAL NUCLEAR PHYSICS (1)

PHYS 751. HIGH ENERGY PHYSICS (3)
Three lectures a week. Co-requisite, PHYS 624 or consent of the instructor. Nuclear forces are studied by examining interactions at high energies. Meson physics, scattering processes, and detailed analysis of high energy experiments.

PHYS 752. ELEMENTARY PARTICLES (3)
Prerequisites, PHYS 624 and 751 or consent of the instructor. Survey of elementary particles and their properties, quantum field theory, meson theory, weak interactions, possible extensions of elementary particle theory.

PHYS 758, 759. SEMINAR IN ELEMENTARY PARTICLES AND QUANTUM FIELD THEORY (1, 1)

PHYS 761. PLASMA PHYSICS (3)
Prerequisite, PHYS 604, 606 or consent of instructor. A detailed study of plasma physics. The first semester treats particle orbit theory, magnetohydrodynamics, plasma waves, and transport phenomena.

PHYS 762. PLASMA PHYSICS (3)
Continuation of PHYS 761. Vlasov theory, including waves, stability, and weak turbulence, kinetic equation theories of correlations and radiative processes.

PHYS 768. SEMINAR IN FLUID DYNAMICS (1)

PHYS 769. SEMINAR IN PLASMA PHYSICS (1)

PHYS 771. COSMIC RAY PHYSICS (3)
Pre- or co-requisite, PHYS 601 or consent of instructor. Interaction of cosmic rays with matter, geomagnetic cutoffs, origin and propagation of cosmic rays, the electron component and its relationship to cosmic radio noise; experimental methods.

PHYS 778. SEMINAR IN SPACE AND COSMIC RAY PHYSICS (1)

PHYS 779. SEMINAR IN GENERAL RELATIVITY (1)

PHYS 788. SEMINAR IN APPLIED PHYSICS (1)

PHYS 789. SEMINAR IN INTERDISCIPLINARY PROBLEMS (1)

PHYS 798. SPECIAL PROBLEMS IN ADVANCED PHYSICS (1-3)
Projects or special study in advanced physics.

PHYS 799. MASTER'S THESIS RESEARCH (1-6)

PHYS 808, 809. SPECIAL TOPICS IN GENERAL PHYSICS (1-4, 1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 818. SPECIAL TOPICS IN GENERAL PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 819. SPECIAL TOPICS IN GENERAL PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 828. SPECIAL TOPICS IN ATOMIC AND MOLECULAR PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 829. SPECIAL TOPICS IN QUANTUM MECHANICS AND QUANTUM ELECTRONICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 832. THEORY OF SOLIDS I (3)
Prerequisite, PHYS 623, co-requisite, PHYS 624. Advanced topics in the quantum theory of solids from such fields as band structure calculations, optical properties, phonons, neutron scattering, the dynamics of electrons in one-band theory, the Landau-Fermi liquid theory, charged Fermi liquids, the Fermi surface (surface impedance, cyclotron resonance, the de Haas-van Alphen effect, etc.).

PHYS 833. THEORY OF SOLIDS II (3)
Continuation of PHYS 832. Covers special topics such as magnetism, superconductivity and electron-phonon interactions.

PHYS 838. SPECIAL TOPICS IN EXPERIMENTAL SOLIDS STATE PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 839. SPECIAL TOPICS IN THEORETICAL SOLID STATE PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 843. THEORETICAL NUCLEAR PHYSICS I (3)
Prerequisite, PHYS 624. Three lectures a week. Nuclear properties and reactions, nuclear forces, two, three, and four body problems, nuclear spectroscopy, beta decay, and related topics.

PHYS 844. THEORETICAL NUCLEAR PHYSICS II (3)
Continuation of PHYS 843. Nuclear properties and reactions, nuclear forces, two, three, and four body problems, nuclear spectroscopy, beta decay, and related topics.

PHYS 848. SPECIAL TOPICS IN EXPERIMENTAL NUCLEAR PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 849. SPECIAL TOPICS IN THEORETICAL NUCLEAR PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 851. ADVANCED QUANTUM MECHANICS (3)
Prerequisite, PHYS 624. Renormalizations of Lagrangian Field Theories, Lamb Shift, Positronium fine structure, T. C. P. invariance, connection between spin and statistics, broken symmetries in many body problems, soluble models, analyticity in perturbation theory, simple applications of dispersion relations.

PHYS 852. THEORETICAL METHODS IN ELEMENTARY PARTICLES (3)
Prerequisite or co-requisite, PHYS 851.

PHYS 853. QUANTUM FIELD THEORY (3)
Co-requisite, PHYS 851. Introduction to Hilbert space, general postulates of relativistic quantum field theory, asymptotic conditions, examples of local field theory. Jost-Lehmann-Dyson representation and applications, generalized free field theory, general results of local field theory-TCP theorem, spin statistics connections. Borchers' theorems, Reeh-Schlieder theorem.

PHYS 858. SPECIAL TOPICS IN ELEMENTARY PARTICLES AND QUANTUM FIELD THEORY (1-4)
Prerequisites, PHYS 851 and 752. First semester.

PHYS 859. SPECIAL TOPICS IN ELEMENTARY PARTICLES AND QUANTUM FIELD THEORY (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 868. SPECIAL TOPICS IN FLUID DYNAMICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 869. SPECIAL TOPICS IN PLASMA PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 875. THEORY OF RELATIVITY (3)
Prerequisite, PHYS 601. A brief survey of Einstein's special theory of relativity followed by a solid introduction to general relativity and its applications.

PHYS 878. SPECIAL TOPICS IN SPACE AND COSMIC RAY PHYSICS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 879. SPECIAL TOPICS IN GENERAL RELATIVITY (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 888. SPECIAL TOPICS IN APPLIED PHYSICS (2)

RECORDING MINIATURE EYE MOVEMENTS
Department of Psychology

DOPING A SILICON WAFER IN THE INTEGRATED CIRCUITS LABORATORY
Department of Electrical Engineering

PHYS 889. SPECIAL TOPICS IN INTERDISCIPLINARY PROBLEMS (1-4)
Prerequisite, consent of instructor. Credit according to work done.

PHYS 899. DOCTORAL DISSERTATION RESEARCH (1-8)

POULTRY SCIENCE PROGRAM

Associate Professor and Chairman: Thomas
Professor: Shaffner
Associate Professor: Bigbee
Assistant Professors: Heath, Pollard, Carter, Soares

Coursework and research activities leading to the Master of Science and the Doctor of Philosophy degrees are offered by the Department of Poultry Science. The student may pursue work with major emphasis in either nutrition; physiology, physiological genetics, or the technology of eggs and poultry.

Departmental requirements, supplementary to those of The Graduate School, have been formulated for the guidance of candidates for graduate degrees. Copies of these requirements may be obtained from the Department of Poultry Science.

Courses in these programs are listed elsewhere under the headings Animal Science, Nutritional Sciences, and Food Science, as appropriate.

PSYCHOLOGY PROGRAM

Professor and Chairman: Bartlett
Professors: Anderson, Crites, Fretz, Goldstein, Gollub, Hodos, Horton, Levinson, Locke,[1] Magoon,[1] Martin, McIntyre, D. Mills, J. Mills, Pumroy,[1] Scholnick, Steinman, Taylor, Tyler, Waldrop
Associate Professor: Brown, Dies, Freeman,[1] Larkin, McKenzie,[1] Pavey, Schneider, Sigall, Smith, Sternheim, Teitelbaum, Ward
Assistant Professors: Barrett, Carroll, Claiborn, Coursey, Dachler, Fretz, Gelso,[1] Holmgren, Johnson, Meltzer, Osterhouse, Specter

[1] joint appointment with Counseling and Personnel Services
[2] joint appointment with Business Administration

The Department of Psychology offers programs leading to the degrees of Master of Arts, Master of Science, and Doctor of Philosophy. By departmental ruling, the number of graduate students is limited to a ratio of four resident students per member of the Graduate Faculty, insuring close and intimate contact in research and seminars.

The programs for the Master of Arts and Master of Science degrees differ in the relative emphasis on content in the social and biological sciences. Programs leading to the Doctor of Philosophy degree are offered in the areas of Clinical, Counseling, Experimental, Industrial, Quantitative and Social Psychology. The Experimental area is further subdivided into three fields of study: bio-psychology; language and cognition; and sensation and perception. Many have a range of subspecialties (e.g., Personality and Developmental, Engineering Psychology) in which the student may concentrate. The department's doctoral programs in both Clinical and Counseling Psychology have been approved by the American Psychological Association.

The department accepts as graduate students only those who have demonstrated superior aptitude and appear capable of completing the requirements for the doctoral degree.

The department gives financial aid to almost all incoming students. A graduate assistant is permitted to register for 10 semester hours. The Department of Psychology does not offer a part-time program. Students are required to attend classes, take part in research and teach as graduate assistants. Each of these assignments is considered a critical part of the graduate training program. It is not possible to obtain this type of education on a part-time basis. Thus, students are not permitted to hold off-campus jobs unless they are under the direct supervision of the faculty.

The department moved into a new building during the Summer of 1971, and new facilities were designed by the faculty of the Department of Psychology for the training of graduate students. In addition, its geographic location in a suburb of Washington, D.C. makes accessible a wide variety of laboratory and training facilities in governmental and other agencies, as well as many psychologists prominent in the profession.

PSYC 400. EXPERIMENTAL PSYCHOLOGY—LEARNING AND MOTIVATION (4)
Two lectures and four 1-hour laboratory periods per week. Prerequisite, PSYC 200 or equivalent. Students who have taken PSYC 301 need consent of instructor. Primarily for students who major in psychology. The experimental analysis of behavior with emphasis on conditioning, learning and motivational processes. Experiments are conducted on the behavior of animals.

PSYC 402. PHYSIOLOGICAL PSYCHOLOGY (3)
Prerequisite, PSYC 410 or consent of instructor. An introduction to research on the physiological basis of human behavior, including considerations of sensory phenomena, motor coordination, emotion, drives, and the neurological basis of learning.

PSYC 403. ANIMAL BEHAVIOR (3)
Prerequisite, PSYC 400 or consent of instructor. A study of animal behavior, including considerations of social interactions, learning, sensory processes, motivation, and experimental methods, with a major emphasis on mammals.

PSYC 410. EXPERIMENTAL PSYCHOLOGY—SENSORY PROCESSES I (4)
Three lectures and one 2-hour laboratory/demonstration period per week. Prerequisite, PSYC 200 or equivalent. Primarily for students who major in psychology. A systematic survey of the content, models, and methodologies of sensory and perceptual research.

PSYC 412. EXPERIMENTAL PSYCHOLOGY—SENSORY PROCESSES II (4)
Two lectures and four hours of laboratory exercise and research per week. Prerequisite, PSYC 410 or consent of instructor. Primarily for psychology majors and majors in biological sciences with a special interest in sensory processes. Lectures and

laboratory exercises will emphasize contemporary problems in sensory process research. Sufficient latitude will be provided so the exceptional student may conduct original research based on findings reported in the current literature.

PSYC 420. EXPERIMENTAL PSYCHOLOGY—SOCIAL BEHAVIOR (4)
Two lectures and two 2-hour laboratory periods per week. Prerequisite, PSYC 200 and 221 or equivalent. A laboratory course dealing with methods of studying behavior in the social context. Topics will include social perception and motivation, small groups, communication and persuasion. Consideration will be given to the techniques involved in laboratory experimentation, field studies, attitude scale construction, and opinion surveys.

PSYC 422. LANGUAGE AND SOCIAL COMMUNICATION (3)
Prerequisite, PSYC 200 and 221 or equivalent, and consent of instructor. The nature and significance of verbal and nonverbal communication in social psychological processes including examination of relevant theoretical approaches to symbolic behavior.

PSYC 423. ADVANCED SOCIAL PSYCHOLOGY (3)
Prerequisite, PSYC 420. A systematic review of research and points of view in regard to major problems in the field of social psychology.

PSYC 431. ABNORMAL PSYCHOLOGY (3)
Prerequisite, PSYC 100 and 200 or equivalent. Theory of behavior deviation and positive mental health; experimental psychopathology; research methodology in psychopathology; psychopathology with neuropathology; theory and research associated with major syndromes of deviant behavior, assessment, diagnosis, and treatment. A student may not receive credit for both PSYC 331 and PSYC 431.

PSYC 433. ADVANCED TOPICS IN CHILD PSYCHOLOGY (3)
Prerequisite, PSYC 200 or equivalent. The growth and transformation of basic psychological processes from birth to maturity. Emphasis is on research data and methodological issues, especially as they relate to other aspects of psychology. A student may not receive credit for both PSYC 333 and 433.

PSYC 435. PERSONALITY (3)
Prerequisite, PSYC 200 or equivalent. Major personality theories, their postulates and evidence; assessment and research methodology in personality; major areas of personality research, their methodologies, findings, implications, and relationships to the field of psychology. A student may not receive credit for both PSYC 335 and 435.

PSYC 436. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
Prerequisites, PSYC 335 or 435, and 431, senior standing. Psychology majors only. Survey and critical analysis of clinical psychology, with emphasis on current developments and trends. Topic areas include, in part, historical and theoretical analyses of trends in clinical psychology; trends in diagnostic assessment; principles underlying various approaches to individual and group psychotherapy; psychotherapy research.

PSYC 441. PSYCHOLOGY OF HUMAN LEARNING (3)
Prerequisite, PSYC 200 or equivalent. Review and analysis of the major phenomena and theories of human learning, including an introduction to the fields of problem solving, thinking and reasoning.

PSYC 451. PRINCIPLES OF PSYCHOLOGICAL TESTING (3)
Three lectures and one 2-hour laboratory period per week. Prerequisite, PSYC 200 or equivalent. A survey of the basic concepts and theories of psychological measurement illustrated through demonstration of principal approaches to psychological testing.

PSYC 452. PSYCHOLOGY OF INDIVIDUAL DIFFERENCES (3)
Prerequisite, PSYC 451. Problems, theories and researches related to psychological differences among individuals and groups.

PSYC 453. MATHEMATICAL PSYCHOLOGY (3)
Prerequisite, PSYC 200 or equivalent, and consent of instructor. A survey of mathematical formulations in psychology, including measurement and scaling models, statistical and psychometric models, and elementary mathematical representations of psychological processes in learning, choice, psychophysics, and social behavior.

PSYC 461. PERSONNEL AND ORGANIZATIONAL PSYCHOLOGY (3)
Prerequisite, PSYC 200 or equivalent, and one other 200 level course. For majors. Intensive examination of issues in personnel psychology (recruitment, selection and classification, job satisfaction) and organizational psychology (motivation, morale, group processes including leadership, organization theory). Emphasis is on theories of behavior in organizations and research results regarding behavior in ongoing human systems. Where appropriate, relations between theory and practice are discussed.

PSYC 462. ENGINEERING PSYCHOLOGY AND TRAINING MODELS (3)
Prerequisite, PSYC 200 or equivalent, and one other 200 level course. For majors. An examination of the theories and research regarding human performance capabilities and skills (information processing, decision-making, environmental constraints, automation), training procedures (traditional methods, programmed learning, computer-assisted instruction) and models and procedures for evaluating training programs in industry, education, and service organizations.

PSYC 467. VOCATIONAL PSYCHOLOGY (3)
Survey and critical analysis of theory and research on vocational choice and vocational adjustment. Definition and correlates of vocational aspirations, preferences, choices, motivation, success, and satisfaction. Developmental trends in career decision-making and career patterns.

PSYC 478. INDEPENDENT STUDY IN PSYCHOLOGY (1-3)
Prerequisite, written consent of instructor. A student who wishes to take independent research study must have completed 12 hours of psychology with at least a 2.5 average. Integrated reading under direction leading to the preparation of an adequately documented report on a special topic. (In special cases, a student who may need to repeat this course in order to complete his independent study, will make a formal request, including a research proposal, through his advisor to the departmental honors committee.)

PSYC 479. SPECIAL RESEARCH PROBLEMS IN PSYCHOLOGY (1-3)
Prerequisite, written consent of instructor. A student who wishes to take independent research study must have completed 12 hours of psychology with at least a 2.5 average. An individual course designed to allow the student to pursue a specialized research topic under supervision. (In special cases, a student who may need to repeat this course in order to complete his research, will make a formal request, including a research proposal, through his advisor to the departmental honors committee.)

PSYC 488-H. ADVANCED PSYCHOLOGY I (HONORS) (3)
Usually taken during junior year. Prerequisites, PSYC 200 and permission of department honors committee. Seminar covering topics in sensation, perception, learning, and motivation.

PSYC 489. SENIOR SEMINAR (3)

PSYC 498-H. ADVANCED PSYCHOLOGY II (HONORS) (3)
Usually taken during senior year. Prerequisite, PSYC 488-H. Semester covering topics in measurement, social processes and other subject matter of current interest.

PSYC 499-H. HONORS THESIS RESEARCH (3)
Usually taken during last semester in residence. Prerequisite, permission of thesis advisor.

PSYC 601, 602. QUANTITATIVE METHODS (3, 3)
Prerequisite, PSYC 200 or equivalent. A basic course in mathematical formulations and quantitative analysis in psychology, with an emphasis on measurement, probability, statistical inference and estimation, regression, and correlation.

PSYC 611. ADVANCED DEVELOPMENTAL PSYCHOLOGY (3)
Empirical, experimental and theoretical literature related to developmental processes.

PSYC 612. THEORIES OF PERSONALITY (3)
Scientific requirements for a personality theory. Postulates and relevant research literature for several current personality theories.

PSYC 619. CLINICAL RESEARCH TEAM (1-3)
Discussion of research topics; presentation and critique of original research proposals in clinical psychology. May be repeated to a maximum of six credits.

PSYC 641. PERSUASION AND ATTITUDE CHANGE (3)
Consideration of the communication process and the various media of mass communication. Factors related to the effectiveness of communication and persuasion are analyzed in the light of experimental evidence, and various strategies and techniques of persuasion are reviewed.

PSYC 642. SEMINAR IN SMALL GROUP BEHAVIOR (3)
Prerequisite, permission of instructor. Review of current approaches to small group behavior, including problem-solving, communication, leadership, and conformity.

PSYC 648. SEMINAR IN SOCIAL PSYCHOLOGY (3)
Analysis and discussion of contemporary systematic positions in social psychology. Review of research methods in the area as well as theories and problems of current importance.

PSYC 651, 661. ADVANCED GENERAL PSYCHOLOGY (3, 3)

PSYC 671. VERBAL BEHAVIOR (3)
Prerequisite, PSYC 471 and 622. Analysis of such topics as verbal learning, psycholinguistics, concept formation, and thinking.

PSYC 687. HISTORICAL VIEWPOINTS AND CURRENT THEORIES IN PSYCHOLOGY (3)

PSYC 688. HISTORICAL VIEWPOINTS AND CURRENT THEORIES IN PSYCHOLOGY (3)

PSYC 701. MULTIVARIATE ANALYSIS I (3)
Prerequisite, PSYC 602, or permisison of instructor. Fundamentals of matrix algebra, multivariate distributions, multivariate estimation problems and test of hypotheses, general linear model.

PSYC 702. MULTIVARIATE ANALYSIS II (3)
Prerequisite, PSYC 701 or permission of instructor. Component and factor analysis with emphasis on the appropriateness of the models to psychological data. Both theoretical issues and research implications will be discussed. The course will treat the factor analytic model, the three indeterminant problems of communalities, factor loadings, and factor scores, extraction algorithms, rotational algorithms, and the principal component model.

PSYC 703. SCALING TECHNIQUES AND THEORY (3)
Prerequisite, PSYC 602 or consent of instructor. Theory of measurement as applied to psychology; and the associated experimental techniques needed to construct measurement scales. The principal psychophysical and psychometric scaling models are discussed.

PSYC 704. TEST THEORY (3)
Prerequisite, PSYC 602 or permission of instructor. A survey of theories of test construction with emphasis on reliability, validity, and criteria problems. Covers measurement in differential psychology, item analysis, reliability, validity, reliability of difference scores, prediction and the construction of test batteries, and factor theory.

PSYC 705. MATHEMATICAL MODELS OF LEARNING AND MEMORY (3)
Prerequisite, PSYC 602 or consent of instructor. Topics to be covered include a review of basic probability theory; matrix operations and difference equations; stochastic models of learning, memory and attention; stimulus sampling theory; computer simulations of learning processes.

PSYC 706. SEMINAR IN PREDICTION (3)
Prerequisite, PSYC 602 or permission of instructor. In depth review of techniques for prediction in the behavioral sciences. Emphasis on both theoretical rationale and research implications.

PSYC 707. THEORY OF DECISION AND CHOICE (3)
Prerequisite, PSYC 602 or consent of instructor. A study of algebraic and probabilistic models for decision and choice behavior, and related experimental procedures. Topics include: measurement of preference, utility and subjective likelihood models for certain and uncertain outcomes, normative strategies, competitive strategies, and group decision making.

PSYC 708. SEMINAR IN PSYCHOMETRIC THEORY (3)
Prerequisite, PSYC 602 or consent of instructor. Study of the current practices, trends, or recent developments in psychometric theory. Repeatable to a maximum of nine hours.

PSYC 709. SEMINAR IN MATHEMATICAL MODELS (3)
Prerequisite, PSYC 602 or consent of instructor. Special topics in mathematical psychology. A discussion of quantitative representations of psychological processes in one or more substantive areas of psychology. Repeatable to a maximum of nine hours.

PSYC 711. INTRODUCTION TO COUNSELING PSYCHOLOGY (3)
Prerequisite, permission of instructor. Introduction to the professional field, examination of pertinent scientific and philosophical backgrounds, and survey of the major theories, principles, and training models in counseling. Correlated laboratory analogue experiences in dyadic and group interrelationships.

PSYC 712. PRINCIPLES AND PROCEDURES OF COUNSELOR FUNCTIONS (3)
Prerequisite, PSYC 711. Specific functions and areas of specialization of the counseling psychologist including vocational psychology, use of tests in counseling, and student ecology. Principles of consultation, interprofessional relations, and ethical standards. Concurrent correlated laboratory experiences for all topics.

PSYC 713. FUNDAMENTALS OF CLINICAL PSYCHOLOGY (3)
Prerequisite, consent of the instructor. Analysis of clinical psychology as a scientist—professional paradigm, its historical roots and its scientific and professional evolution; selected coverage of current major research topics, e.g., psychotherapy, psychopathology, community; current nature of clinical psychology and evolving trends.

PSYC 718. RESEARCH ISSUES IN CLINICAL, COUNSELING, AND COMMUNITY PSYCHOLOGY (3)
Prerequisite, permission of instructor. Issues and strategies in conceptual systems, designs and methodologies of current research in these areas; critical analysis of current research. May be repeated to a maximum of nine credits.

PSYC 719. SEMINAR IN CLINICAL COUNSELING, AND COMMUNITY PSYCHOLOGY (3)
Prerequisite, permission of instructor. Advanced selected topics in areas such as psychotherapy, consultation, assessment, psychopathology, student ecology, etc. May be repeated to a maximum of nine credits.

PSYC 721. SEMINAR AND LABORATORY IN BEHAVIORAL ASSESSMENT I (2, 2)
Prerequisite, consent of instructor. PSYC 721 and 722 must be taken concurrently. Introduction to a broad range of assessment approaches, issues, theories and research. Emphasis formulation and evaluation of strategies for information gathering and problem solving in a variety of clinical situations and includes behavorial observations, rating procedures and standardized tests.

PSYC 723. 724. SEMINAR AND LABORATORY IN BEHAVIORAL ASSESSMENT II (2, 2)
Prerequisite, consent of instructor. PSYC 723 and 724 must be taken concurrently. Introduction to a broad range of assessment approaches, issues, theories and research. Emphasizes formulation and evaluation of strategies for information gathering and problem solving in a variety of clinical situations and includes behavioral observations, rating procedures and standardized tests.

PSYC 727. INTRODUCTORY COUNSELING PRACTICUM (3)
Prerequisite, PSYC 711 and 712. Supervised training in application of methods relevant to behavior change through counseling.

PSYC 728. INTRODUCTORY DIDACTIC-PRACTICUM IN PSYCHOLOGICAL INTERVENTION (3)
Prerequisite, permission of instructor. Introduction to concepts and skills of psychological intervention emphasizing the relationship to the behavioral science foundation theories, methods and research findings with the development and utilization of intervention skills. The course includes supervised experience in intervention skills as designated by the subtopics of the course. May be repeated to a maximum of nine credits.

PSYC 729. ADVANCED DIDACTIC-PRACTICUM IN PSYCHOLOGICAL INTERVENTION (3)
Prerequisite, consent of instructor and PSYC 727 or 728. Concept, research and supervised experience in intervention skills in advanced specialized areas, e.g., college student counseling, child evaluation, parent and school consultation, psychoevaluation, behavioral therapy, individual psychotherapy. May be repeated to a maximum of nine hours.

PSYC 730. INTRODUCTION TO INDUSTRIAL AND ORGANIZATIONAL PSYCHOLOGY (3)
Advanced survey of industrial-organizational psychology, including selection, training, human en-

gineering, motivation, group processes, leadership, organizational psychology, and some topics in research methods including philosophy of science. Readings stressed and seminar time will be used for discussion and integration of the reading materials. Various faculty members will serve as content experts.

PSYC 731. TRAINING PROCEDURES AND EVALUATION IN ORGANIZATIONAL SETTINGS (3)
Psychological principles and methods in the development and evaluation of training procedures in business and industry, government and military, and educational and service institutions. Included are discussions of learning foundations, and training methodology (simulators, programmed instruction, computer-assisted instruction). The focus of the course is the design of evaluation research in social settings.

PSYC 732. SELECTION AND CLASSIFICATION ISSUES IN ORGANIZATIONS (3)
Prerequisite, PSYC 730. PSYC 601-602 or the equivalents, or permission of the instructor. Consideration of societal, organizational and individual demands for appropriate use of individual differences in (primarily) initial placement of employees. Recruitment and selection issues, the role of governmental regulations, and the role of individual factors in individual behavior are considered. Extensive coverage given to fundamental psycho-metric problems and the development of individual and organizational criteria of effectiveness.

PSYC 733. ORGANIZATIONAL PSYCHOLOGY (3)
Prerequisite, PSYC 730, PSYC 601-602 or their equivalents or permission of the instructor. Emphasis theories and data regarding the impact of environmental factors on individual, group, and organizational behavior. Group dynamics, leadership and power, motivation and satisfaction, and organization structure and environment are examined as correlates of behavior.

PSYC 734. MOTIVATION AND ATTITUDES IN ORGANIZATIONS (3)
Prerequisite, permission of the instructor. Major theories of human motivation in organizational contexts. Included will be theories concerning some determinants of performance, satisfaction and dissatisfaction, the relationship between satisfaction and performance, determinants of boredom and fatigue, and the functions and effects of incentives.

PSYC 735. SEMINAR IN HUMAN PERFORMANCE THEORY (3)
Prerequisite, permission of the instructor. An examination of man-machine interaction with emphasis on the theories and research which focus on human performance capabilities and skills. Some of the topics covered are information processing and communications, decision-making, environmental constraints and automation.

PSYC 738. SEMINAR IN INDUSTRIAL PSYCHOLOGY (3)
An advanced seminar covering specialized topics such as: morale and motivation, labor relations, consumer motivations, man-machine systems, quantitative and qualitative personnel requirements inventory, job evaluation, environment conditions and safety, occupational choice and classification, and the interview.

PSYC 740. INTERVIEW AND QUESTIONNAIRE TECHNIQUES (3)
Psychological concepts and methods in the use of interview, questionnaire, and inventory procedures for the measurement, prediction and alteration of behavior.

PSYC 761. ADVANCED LABORATORY TECHNIQUES (1-3)
Methodology of the automatization of research techniques and apparatus; apparatus design and construction; telemetric and digital techniques; logical block circuitry.

PSYC 762. COMPARATIVE PSYCHOLOGY (3)
Prerequisite, PSYC 661. The experimental literature on the behavior of infra-human organisms. Special topics.

PSYC 763. ADVANCED PSYCHOPHYSIOLOGY (3)

PSYC 765. SEMINAR IN PSYCHOPHARMACOLOGY (3)
Prerequisite, one year of graduate study in psychology and consent of the instructor. A critical review and detailed analysis of the literature and problems related to the effects of drugs on animal and human behavior. Designed for advanced graduate students in experimental psychology and clinical psychology.

PSYC 768. CONDITIONING AND LEARNING (3)
Prerequisite, PSYC 622. The literature on the experimental analysis of behavior, with examination of basic experiments and contemporary theories related to them.

PSYC 788, 789. SPECIAL RESEARCH PROBLEMS (1-4)
Supervised research on problems selected from the area of experimental, industrial, social, quantitative, or mental health psychology.

PSYC 798. GRADUATE SEMINAR (2)

PSYC 799. MASTER'S THESIS RESEARCH (1-6)

PSYC 818. RESEARCH ISSUES IN PERSONALITY OR DEVELOPMENT (3)
Prerequisites, PSYC 601, 602 and either 611 or 612 or their equivalents, depending on course content. Experimental design and methodology and statistical treatment of data appropriate to personality or developmental research; critical analysis of major current areas of research including methodologies, findings and implications. The course will focus on either personality research or developmental research in a given semester. May be repeated to a maximum of nine hours.

PSYC 819. SEMINAR IN PERSONALITY AND DEVELOPMENT
An advanced seminar covering specialized topics. Repeatable to a maximum of nine credits.

PSYC 858. SENSORY AND PERCEPTUAL PROCESSES (3)
Prerequisite, PSYC 402 and 651. The contemporary

experimental theoretical literature on selected problems in sensation and perception.

PSYC 888. RESEARCH METHODS IN PSYCHOLOGY (1-3)

PSYC 889. RESEARCH METHODS IN PSYCHOLOGY (1-3)

PSYC 898. GRADUATE SEMINAR (2)

PSYC 899. DOCTORAL DISSERTATION RESEARCH (1-8)

RECREATION PROGRAM

Professor and Chairman: Harvey
Associate Professors: Churchill, Strobell

The Department of Recreation offers programs of study leading to the degrees of Master of Arts and Doctor of Philosophy seeking to further assist the practitioner, to prepare teachers for institutions of higher learning, and to advance the knowledge in and of the field through research activities and projects.

Present areas of specialization consist of administration, outdoor recreation, program planning, resource planning and management, and therapeutic recreation.

Students are required to present Graduate Record Examination scores and evidence of any experience in addition to fulfilling the regular admission requirements of The Graduate School.

A diagnostic examination is required of all non-Maryland graduates, from the results of which the need for specific prerequisite coursework may be established. Doctoral students must complete either a language requirement or an approved research substitute. A thesis or dissertation is required of all students.

Recreation students have access to the University's McKeldin Library, the College's Research Laboratory and statistical resources, the Computer Science Center, the almost unlimited facilities and subjects of the metropolitan areas of Baltimore, Washington, D.C., and to the headquarters and offices of appropriate national organizations, agencies and federal governmental units in the nation's capitol.

RECR 415. QUANTITATIVE METHODS (3)
A course covering the statistical techniques most frequently used in research pertaining to recreation. An effort will be made to provide the student with the necessary skills, and to acquaint him with the interpretations and practical applications of these techniques.

RECR 420. PROGRAM PLANNING (3)
Prerequisite, RECR 130 or 325. Study of the various aspects, problems and practices of agency, military, "exceptional" and government recreation programs (with particular emphasis on park, playground, community center plans and procedures). Observations will be required.

RECR 426. INDUSTRIAL RECREATION (3)
An introductory study of the philosophy of and practices and problems in industrial recreation. Where possible the course will include opportunities for observation and for meeting visiting specialists.

RECR 432. PHILOSOPHY OF RECREATION (3)
A study of the meanings, relationships, and services of recreation as expressed by past and present authorities and leaders. This course should be of interest to people active in education, social work, and related fields.

RECR 450. CAMP MANAGEMENT (3)
Prerequisite, RECR 150 or experience. An advanced camping course for those students with previous training and experience; organization, administration, programming, current trends, evaluation, and special problems. Whenever possible, visiting specialists and field trips will be included.

RECR 454. OUTDOOR EDUCATION (6)
Field experience and resident camping in an outdoor setting will be used to present the activities and techniques recommended for modern outdoor education practice. Where possible groups of participants will be utilized as subjects for practice instructional work. Activity will emphasize not only the subject matter of science and outdoor education but also the broad concepts of conservation, worthy use of leisure time· education for democratic living, etc.

RECR 460. LEADERSHIP TECHNIQUES AND PRACTICES (3)
Prerequisite, RECR 130 or 325. A study of the various kinds and levels of leadership exerted by professional and volunteer workers, some of the difficulties and probable weaknesses to be met, and some of the tangible techniques to be used with personnel, staff and in public relationships. The group work approach will be emphasized and used, insofar as possible, in the solution of particular problems that grow out of the required field experience in directing on or off campus groups.

RECR 463. SUPERVISORY TECHNIQUES IN RECREATION (3)
A study of the principles, methods, and techniques as well as an analysis of the functions of supervision in the recreation and parks environment. This course is designed to advance the student's understanding of the art of building human relationships, and to apply the emerging concepts and principles of modern supervision to practical situations in which administrators, supervisors, leaders (both professional and paraprofessional) and volunteers are working.

RECR 476. HOSPITAL RECREATION (3)
An introductory study of the philosophy of and practices in hospital and institutional recreation. Where possible the course will include opportunities for observation and for meeting visiting specialists.

RECR 489. FIELD LABORATORY PROJECTS AND WORKSHOP (1-6)
A course designed to meet the needs of persons in the field with respect to workshops and research projects in special areas of knowledge not covered by regularly structured courses.

RECR 490. ORGANIZATION AND ADMINISTRATION OF RECREATION (3)
A study of the organizational patterns and administrative problems involved in the various types of operating recreation departments and agencies; forms of organization; finance and budget; personnel; public relations.

RECR 495. PLANNING, DESIGN AND MAINTENANCE OF PARK AND RECREATIONAL AREAS AND FACILITIES (3)
Prerequisites, RECR 130 or 325. A study of the relation of the park and recreation system to the total community planning process; area layout, design and maintenance of facilities. Field experience will include the conduct of community surveys and preparation of site plans as requested by community groups. The development of such studies will include inspection of areas, site analysis, preparation of plans, and their presentation to the community where possible.

RECR 600. SEMINAR IN RECREATION (1)
Presentation, discussion and defense of student thesis proposals and outlines and/or of appropriate faculty projects and research activities.

RECR 610. METHODS AND TECHNIQUES OF RESEARCH (3)
A study of appropriate research methodology including experimental, historical, philosophical, sociological and case study techniques, examples and problems. Each student is required to develop a specimen thesis or dissertation proposal and outline.

RECR 613. SOURCE MATERIAL SURVEY (3)
Study and use of library resources and bibliographical materials of all types through their application to varieties of research problems and interests. Each student carries out special projects of his own initiation.

RECR 633. FOUNDATIONS OF RECREATION (3)
A broad study of the sociological, psychological and economic forces that historically have structured attitudes toward leisure and the development of recreation.

RECR 634. MODERN TRENDS IN RECREATION (3)
A broad study and overview of the recent advances in the several sub areas of recreation: public sector (local, state, Federal and international government involvements); therapeutic (for special groups, such as ill, delinquent, aging, etc.); employee; voluntary agencies; religious organizations; family, school, camping areas; private and commercial sector. Each student will carry out special projects according to his interests.

RECR 687. ADVANCED SEMINAR (1-3)
Prerequisite; consent of instructor. Advanced topics in the various areas of recreation. May be taken for repeated credits, up to a total of 3.

RECR 688. SPECIAL PROBLEMS IN RECREATION (1-6)

RECR 690. ADMINISTRATIVE DIRECTION OF RECREATION (3)
This course is concerned with analyzing various problems in the administration of leisure services in parks and other recreational settings. Students concentrate on simulated situations and their own on-the-job problems to enhance their understanding of sound administrative practice and to improve their problem-solving and decision-making abilities.

RECR 700. ADVANCED DOCTORAL SEMINAR (1)
Presentation, discussion and defense of doctoral dissertation proposals and outlines and/or of appropriate faculty projects and research activities.

RECR 799. MASTER'S THESIS RESEARCH (1-6)

RECR 899. DOCTORAL DISSERTATION RESEARCH (1-8)

SECONDARY EDUCATION PROGRAM

Professor and Chairman: Risinger
Professors: Campbell, Gardner,[1] Grambs, Grentzer,[2] Lockard,[3] Walbesser, Woolf
Associate Professors: Adkins, Anderson, Blum,[2] Brigham,[4] Carr, Davidson,[6] Farrell,[5] Fey,[6] Funaro, Henkelman,[6] Lemmon,[7] Longley,[8] Love,[9] McWhinnie,[18] Peters, Taylor[2]
Assistant Professors: Cirrincione,[11] Croft, Davey,[4] DeLorenzo,[12] Green, James,[11] Layman,[13] McArthur, Pfister,[15] Ricci, Wrenn[9]

[1] joint appointment with Chemistry
[2] joint appointment with Music
[3] joint appointment with Botany
[4] joint appointment with Early Childhood-Elementary Education
[5] joint appointment with History
[6] joint appointment with Mathematics
[7] joint appointment with General Home Economics
[8] joint appointment with Art
[9] joint appointment with Physical Education
[10] joint appointment with Housing and Applied Design
[11] joint appointment with Geography
[12] joint appointment with Spanish and Portuguese
[13] joint appointment with Physics and Astronomy
[14] joint appointment with English
[15] joint appointment with Germanic and Slavic languages

The Department of Secondary Education offers programs leading to the Master of Arts and Master of Education, the Advanced Graduate Specialist, and the Doctor of Philosophy and Doctor of Education. The department offers a variety of programs emphasizing specialized areas of competency appropriate to secondary education. Among the areas of emphasis are: art education, business education, English (language arts) education, foreign language education, home economics education, mathematics education, music education, reading education, science education, social studies education, and speech education. For specific information concerning the requirements for the various degree programs students should contact the department.

EDSE 402. METHODS AND MATERIALS IN TEACHING BOOKKEEPING AND RELATED SUBJECTS (3)
Important problems and procedures in the mastery of bookkeeping and related office knowledge and

the skills including a consideration of materials and teaching procedures.

EDSE 403. PROBLEMS IN TEACHING OFFICE SKILLS (3)
Problems in development of occupational competency, achievement tests, standards of achievement, instructional materials, transcription, and the integration of office skills.

EDSE 404. BASIC BUSINESS EDUCATION IN THE SECONDARY SCHOOLS (3)
Includes consideration of course objectives; subjectives; subject matter selection; and methods of organization and presenting business principles, knowledge and practices.

EDSE 415. FINANCIAL AND ECONOMIC EDUCATION I (3)
Problems of teaching courses in personal finance and economics in the public schools, including materials and resources.

EDSE 416. FINANCIAL AND ECONOMIC EDUCATION II (3)
Continuation of EDSE 415.

EDSE 420. ORGANIZATION AND COORDINATION OF DISTRIBUTIVE EDUCATION PROGRAMS (3)
This course deals specifically with such areas as the organization of a cooperative distributive education program; the development on an effective cooperative relationship between coordinator and training sponsor; the selection, orientation, and training of sponsors; analysis of training opportunities, reports and records; the evaluation and selection of students for part-time cooperative work assignments; and the evaluation of the program.

EDSE 421. METHODS AND MATERIALS IN DISTRIBUTIVE EDUCATION (3)
This course covers basic methods and materials needed to teach the preparatory classroom related instruction of a one or two year distributive education program. It deals specifically with the organization of special supplementary materials for individual and group instruction-youth club programs, organization and administration.

EDSE 423. FIELD EXPERIENCES IN VOCATIONAL AREAS (3)
A. Home Economics Education, B. Business Education, C. Distributive Education. Supervised work experience in an occupation related to vocational education. Application of theory to work situations as a basic for teaching in vocational education programs. By individual arrangement with advisor.

EDSE 425. CURRICULUM DEVELOPMENT IN HOME ECONOMICS (3)
Bases for curriculum decisions; tools for planning and evaluating curriculum; methodology of conceptual teaching.

EDSE 426. EVALUATION OF HOME ECONOMICS (3)
The meaning and function of evaluation in education; the development of a plan for evaluating a homemaking program with emphasis upon types of evaluation devices, their construction and use.

EDSE 430. CORRECTIVE-REMEDIAL READING INSTRUCTION (3)

EDSE 431. LABORATORY PRACTICES IN READING (2-4)

EDSE 432. THE JUNIOR HIGH SCHOOL (2-3)
A general overview of the junior high school. Purposes, functions and characteristics of this school unit; a study of its population, organization, program of studies, methods, staff, and other topics, together with their implications for prospective teachers.

EDSE 440. METHODS OF TEACHING ENGLISH IN SECONDARY SCHOOLS (3)

EDSE 441. PRACTICUM IN ART EDUCATION (3)
One 2-hour lecture discussion period and two, 2-hour laboratory sessions per week. Instruction will be aimed at reviewing experiences in a chosen medium of art and assembling a workable procedure to present the content to secondary school students. The course will provide a studio setting in which the student will assemble materials for an in-depth study of the practical work involved and attempt to develop a total concept in a particular area of art.

EDSE 442. TEACHING THE AUDIO-LINGUAL SKILLS IN FOREIGN LANGUAGES (3)

EDSE 444. METHODS OF TEACHING MATHEMATICS IN SECONDARY SCHOOLS (3)

EDSE 446. METHODS OF TEACHING SCIENCE IN SECONDARY SCHOOLS (3)

EDSE 447. METHODS OF TEACHING SOCIAL STUDIES IN SECONDARY SCHOOLS (2-3)

EDSE 450. SPEECH METHODS OND RESOURCES IN SECONDARY SCHOOLS (3)

EDSE 453. THE TEACHING OF READING IN THE SECONDARY SCHOOL (3)

EDSE 460. ENVIRONMENTAL EDUCATION (3)
Two lecture-discussion periods and one 3-hour laboratory-field experience session per week. An interdisciplinary course covering the literature, techniques and strategies of environmental education. Emphasis is upon the study of environmental education programs and the development of a specific program which is designed to implement the solution of an environmental problem. The laboratory-field experience is provided as a model for future activities of students. Open to any student who wishes to become actively involved in the process of environmental education program development.

EDSE 470. TEACHING OF ART CRITICISM IN PUBLIC SCHOOLS (3)
Introduction to various alternative theories of aesthetics as related to the teaching of art.

EDSE 489. FIELD EXPERIENCE IN EDUCATION (1-4)
Prerequisites, at least six semester hours in education at the University of Maryland plus such other prerequisites as may be set by the secondary education department. Planned field experience may be provided for selected students who have had teaching experience and whose application for such field

experience has been approved by the secondary education faculty. Field experience is offered in a given area to both major and non-major students. *NOTE:* The total number of credits which a student may earn in EDSE 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDSE 498. SPECIAL PROBLEMS IN EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDSE 499. WORKSHOPS, CLINICS, AND INSTITUTES (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the College of Education (or developed cooperatively with other colleges and universities) and not otherwise covered in the present course listing; clinical experiences in pupil-testing centers, reading clinics, speech therapy laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDSE 600. ADMINISTRATION AND SUPERVISION OF BUSINESS EDUCATION (3)
Major emphasis on departmental organization and its role in the school program, curriculum, equipment, budget-making, supervision, guidance, placement and follow-up, school-community relationships, qualifications and selection of teaching staff, visual aids, and in-service programs for teacher development. For administrators, supervisors, and teachers.

EDSE 605. PRINCIPLES AND PROBLEMS OF BUSINESS EDUCATION (2-3)
Principles, objectives, and practices in business education; occupation foundations; current attitudes of business, labor and school leaders; general business education relation to consumer business education and to education in general.

EDSE 606. CURRICULUM DEVELOPMENT IN BUSINESS EDUCATION (2-3)
This course is especially designed for graduate students interested in a concentrated study of curriculum planning in business education. Emphasis will be placed on the philosophy and objectives of the business education program, and on curriculum research and organization of appropriate course content.

EDSE 625 INTRODUCTION TO FIELD METHODS IN SCHOOL AND COMMUNITY (3)
Prerequisite: Permission of instructor. Applies selected field methods to problems of professional practice. Issues pertaining to the role and responsibilities of the field investigator, working in schools and other service agencies. Students will design one or more field studies utilizing qualititative field techniques.

EDSE 626. PROBLEMS IN TEACHING READING IN SECONDARY SCHOOLS (3)
Problems in the teaching of reading in the secondary school. Implications of current theory and the results of research for the teaching of reading in the secondary school. Attention is given to all areas of development reading instruction, with special emphasis on persistent problems.

EDSE 630. DIAGNOSIS AND REMEDIATION OF READING DISABILITIES (3)
Prerequisites, EDEL 325 and 430. For those who wish to become corrective and remedial reading specialists. Concerned with clinical techniques, instructional materials, and remedial procedures useful to the reading specialist in (1) diagnosing serious reading difficulties and (2) planning programs of individual and small-group instruction. The work includes the writing of diagnostic and progress reports.

EDSE 631. ADVANCED LABORATORY EXPERIENCES IN READING INSTRUCTION (3)
Prerequisite, at least 21 credits applicable to the Master's program in corrective and remedial reading. The first semester of the course deals with diagnostic techniques. Each participant will assist in diagnosing reading disabilities and in recommending instructional programs for individual pupils. The second semester deals with instruction of pupils with reading disabilities. Each participant will plan and execute a program of instruction for an individual or a small group, applying findings of the preliminary diagnosis.

EDSE 632. ADVANCED LABORATORY EXPERIENCES IN READING INSTRUCTION (3)
Prerequisites, at least 21 credits applicable to the Master's program in corrective and remedial reading. The first semester of the course deals with diagnostic techniques. Each participant will assist in diagnosing reading disabilities and in recommending instructional programs for individual pupils. The second semester deals with instruction of pupils with reading disabilities. Each participant will plan and execute a program of instruction for an individual or a small group, applying findings of the preliminary diagnosis.

EDSE 637. SEMINAR IN SECONDARY EDUCATION (3)

EDSE 640. TRENDS IN SECONDARY SCHOOL CURRICULUM—GENERAL (3)
Recent developments in educational thinking and practice which have affected the curriculum.

EDSE 641. TRENDS IN SECONDARY SCHOOL CURRICULUM—ART (3)
Recent developments in educational thinking and practice which have affected the curriculum in art education.

EDSE 642. TRENDS IN SECONDARY SCHOOL CURRICULUM—BUSINESS (3)
Recent developments in educational thinking and practice which have affected the curriculum in business education.

EDSE 643. TRENDS IN SECONDARY SCHOOL CURRICULUM—DISTRIBUTIVE EDUCATION (3)
Recent developments in educational thinking and practice which have affected the curriculum in distributive education.

EDSE 644. TRENDS IN SECONDARY SCHOOL CURRICULUM—ENGLISH (3)
Recent developments in educational thinking and practice which have affected the curriculum in English education.

EDSE 645. TRENDS IN SECONDARY SCHOOL CURRICULUM—FOREIGN LANGUAGE (3)
Recent developments in educational thinking and practice which have affected the curriculum in foreign language education.

EDSE 646. TRENDS IN SECONDARY SCHOOL CURRICULUM—GEOGRAPHY (3)
Recent developments in educational thinking and practice which have affected the curriculum in geography.

EDSE 647. TRENDS IN SECONDARY SCHOOL CURRICULUM—MATHEMATICS (3)
Recent developments in educational thinking and practice which have affected the curriculum in mathematics.

EDSE 650. TRENDS IN SECONDARY SCHOOL CURRICULUM—SCIENCE (3)
Recent developments in educational thinking and practice which have affected the curriculum in science education.

EDSE 651. TRENDS IN SECONDARY SCHOOL CURRICULUM—SOCIAL STUDIES (3)
Recent developments in educational thinking and practice which have affected the curriculum in social studies.

EDSE 652. TRENDS IN SECONDARY SCHOOL CURRICULUM—SPEECH (3)
Recent developments in educational thinking and practice which have affected the curriculum in speech.

EDSE 653. TRENDS IN SECONDARY SCHOOL CURRICULUM—URBAN SCHOOLS (3)
Recent developments in educational thinking and practice which have affected the curriculum in urban schools.

EDSE 654. TRENDS IN SECONDARY SCHOOL CURRICULUM—READING (3)
Prerequisites, EDSE 453, EDMS 446. Recent developments in educational thinking and practice which have affected the curriculum in reading.

EDSE 700. HISTORY OF ART EDUCATION (3)
A study of the growth of the art curriculum in American schools. Perspective on art education philosophy as viewed through a historical survey beginning with the United States colonial period to the present.

EDSE 701. THE TEACHING OF ART CRITICISM (3)
The aesthetic foundations of art education. Development of skills necessary for critical investigation of works of art, and identification of curriculum implications resulting from various aesthetic and psychological approaches to art.

EDSE 705. TRENDS IN THE TEACHING AND SUPERVISION OF HOME ECONOMICS (3)
Study of home economics programs and practices in light of current educational trends. Interpretation and analysis of democratic teaching procedures, outcomes of instruction, and supervisory practices.

EDSE 740. THEORY AND RESEARCH IN SECONDARY EDUCATION—GENERAL (1-3)
A survey of the research literature; evaluation of research techniques; consideration of relevant instructional curriculum theory; evaluation of modern teaching methods and techniques.

EDSE 741. THEORY AND RESEARCH IN SECONDARY EDUCATION—ART (1-3)
See EDSE 740 for description.

EDSE 742. THEORY AND RESEARCH IN SECONDARY EDUCATION—BUSINESS (1-3)
See EDSE 740 for description.

EDSE 743. THEORY AND RESEARCH IN SECONDARY EDUCATION—DISTRIBUTIVE EDUCATION 1-3)
See EDSE 740 for description.

EDSE 744. THEORY AND RESEARCH IN SECONDARY EDUCATION—ENGLISH (1-3)
See EDSE 740 for description.

EDSE 745. THEORY AND RESEARCH IN SECONDARY EDUCATION—FOREIGN LANGUAGE (1-3)
See EDSE 740 for description.

EDSE 746. THEORY AND RESEARCH IN SECONDARY EDUCATION—HOME ECONOMICS (1-3)
See EDSE 740 for description.

EDSE 747. THEORY AND RESEARCH IN SECONDARY EDUCATION—MATHEMATICS (1-3)
See EDSE 740 for description.

EDSE 750. THEORY AND RESEARCH IN SECONDARY EDUCATION—MUSIC (1-3)
See EDSE 740 for description.

EDSE 751. THEORY AND RESEARCH IN SECONDARY EDUCATION—READING (1-3)
See EDSE 740 for description.

EDSE 752. THEORY AND RESEARCH IN SECONDARY EDUCATION—SCIENCE (1-3)
See EDSE 740 for description.

EDSE 753. THEORY AND RESEARCH IN SECONDARY EDUCATION—SOCIAL STUDIES (1-3)
See EDSE 740 for description.

EDSE 754. THEORY AND RESEARCH IN SECONDARY EDUCATION—SPEECH (1-3)
See EDSE 740 for description.

EDSE 755. THEORY AND RESEARCH IN SECONDARY EDUCATION—URBAN EDUCATION (1-3)
See EDSE 740 for description.

EDSE 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisers may register for credit un-

der this number. Course card must have the title of the problem and the name of the faculty member under whom the work will be done.

EDSE 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for master's thesis.

EDSE 820. SEMINAR IN ART EDUCATION (3)

EDSE 821. SEMINAR IN BUSINESS EDUCATION (3)

EDSE 822. SEMINAR IN COMPUTER ASSISTED INSTRUCTION (3)

EDSE 823. SEMINAR IN DISTRIBUTIVE EDUCATION (3)

EDSE 824. SEMINAR IN ENGLISH EDUCATION (3)

EDSE 825. SEMINAR IN FOREIGN LANGUAGE EDUCATION (3)

EDSE 826. SEMINAR IN HOME ECONOMICS EDUCATION (3)

EDSE 827. SEMINAR IN MATHEMATICS EDUCATION (3)

EDSE 830. SEMINAR IN READING EDUCATION (3)
Prerequisite, EDSE 751. Exploration of major issues of theory, research and program development of concern to those in positions of advanced professional leadership. Interinstitutional and interdisciplinary factors will be considered.

EDSE 831. SEMINAR IN SCIENCE EDUCATION (3)

EDSE 832. SEMINAR IN SOCIAL STUDIES EDUCATION (3)

EDSE 833. SEMINAR IN SPEECH EDUCATION (3)

EDSE 834. SEMINAR IN URBAN EDUCATION (3)
EDSE 835. SEMINAR IN BEHAVIORAL OBJECTIVES (3)

EDSE 888. APPRENTICESHIP IN EDUCATION (1-9)
Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the education faculty. Each apprentice is assigned to work for at least a semester fulltime or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprenticeship maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's Degree in education, and at least six semester hours in education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDSE 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDSE 889. INTERNSHIP IN EDUCATION (3-16)
Internships in the major area of study are available to selected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the Doctor's Degree; and (b) any student who receives special approval by the education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a fulltime basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *Note:* The total number of credits which a student may earn in EDSE 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSE 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an Ed.D. project and 12-18 hours required for a PhD. dissertation.

SOCIOLOGY PROGRAM

Associate Professor and Acting Chairman: Lengermann
Professors: Dager, Janes, Lejins
Associate Professors: Cussler, Henkel, Hirzel, McIntyre, Meeker, Pease
Assistant Professors: Finsterbusch, Franz, Greisman, Harper, Hornung, Hunt, L., Kruegel, Mortimer, Schwartz

The graduate program in Sociology offers coursework leading to M.A. and Ph.D. degrees but is primarily designed for students who wish to obtain the Ph.D However, entrance to the Ph.D. program requires completion of requirements for the M.A. at this university or another.

Admission to the graduate program is based upon letters of recommendation, GRE scores, student's prior academic record, and other information relevant to the applicant's chances of successfully completing the program. Additionally, students are considered to be properly prepared for graduate work in sociology if they have had the following undergraduate courses: mathematics through college algebra, elementary statistics, introduction to sociological theory, research methods, and philosophy of science or symbolic logic. Students deficient in any of these areas may be admitted to the program but must satisfy the requirements either before or upon entering the program.

A minimum of 30 hours is required for the Master's degree. Five courses are required and are intended to give students a sound grounding in theory, methods, and statistics. In addition, the student is required to complete six hours of research credit and nine hours of electives, the latter usually chosen in the student's area of specialization. A final oral exam is held centering on the research paper or thesis but including other subsidiary substantive and theoretical issues emerging from the research. Usually, this phase of the program can be completed in two years.

On completion of all requirements for the M.A., and independent of its conferral, each student is evaluated by a committee of the faculty for admission to the doctoral program. On admission to the doctoral program, the student, in consultation with his advisor and committee, pursues a plan of study in his area of specialization. Required courses are held to a minimum

(six hours) to enable the student to create a program most suited to his or her needs.

The student must successfully complete comprehensive examinations in three areas: Social Psychology, Social Organization, and the chosen area of specialization. The foreign language requirement can be satisfied by passing a language exam or making a "B" or better in one of eleven other tool courses.

SOCY 401. INTERMEDIATE STATISTICS FOR SOCIOLOGISTS (3)
Prerequisites, SOCY 201 or equivalent and six additional credits in sociology. Intermediate correlation techniques, analysis of variance, sampling, additional non-parametric techniques, additional topics in inferential statistics. Required of all candidates for the A.A. degree.

SOCY 410. POPULATION (3)
Prerequisite, SOCY 100 or 200. Population distribution and growth in the United States and the world; population characteristics of the United States; resulting population problems and policies.

SOCY 411. POPULATION (3)
Prerequisite, SOCY 201 and 410 or equivalent statistical training. Trends in fertility and mortality, migrations, population estimates, and the resulting problems and policies.

SOCY 421. INTERCULTURAL SOCIOLOGY (3)
Prerequisite, SOCY 200. On the basis of a comparative study of customs, individual and group behavior patterns and institutions, this course studies the ideologies of America and other modern societies.

SOCY 423. ETHNIC MINORITIES (3)
Prerequisite, SOCY 100 or 200. Basic social processes in the relations of ethnic groups; immigration groups and the Negro in the United States; ethnic minorities in Europe.

SOCY 424. SOCIOLOGY OF RACE RELATIONS (3)
Prerequisite, SOCY 100 or 200. Race as a focus of social relations. Political and collective action centering on race relations. New myths of race. Trends in assimilation of racial groups.

SOCY 426. SOCIOLOGY OF RELIGION (3)
Prerequisite, SOCY 100 or 200. Varieties and sources of religious experience. Religious institutions and the role of religion in social life.

SOCY 427. DEVIANT BEHAVIOR (3)
Prerequisite, SOCY 100 or 200. Current theories of the genesis and distribution of deviant behavior. Definitions of deviance, labeling theory, secondary deviance. Theories of specific forms of deviant behavior will be examined for their implications for a general theory of deviant behavior.

SOCY 430. SOCIOLOGY OF PERSONALITY (3)
Prerequisite, SOCY 100 or 200. Development of human nature and personality in contemporary social life; processes of socialization; attitudes, individual differences and social behavior.

SOCY 431. FORMAL AND COMPLEX ORGANIZATIONS (3)
Prerequisite, SOCY 100 or 200. The concept of formal organization. The study of functioning and control in the operation of bureaucracies such as corporations and in large-scale organizations such as military, religious and educational hierarchies. Forms of recruitment, internal mobility and organizational personality. Relations between large-scale organizations and with the larger society.

SOCY 432. COLLECTIVE BEHAVIOR (3)
Prerequisite, SOCY 100 or 200. Social interaction in mass behavior; communication processes; structure and functioning of crowds, strikes, audiences, mass movements, and the public.

SOCY 433. SOCIAL CONTROL (3)
Prerequisite, SOCY 100 or 200. Forms, mechanisms, and techniques of group influence on human behavior; problems of social control in contemporary society.

SOCY 441. SOCIAL STRATIFICATION (3)
Prerequisite, 9 credits of sociology. An introduction to the sociology of social stratification. Consideration of the basic concepts and major findings in the field. The relationship of social stratification to the institutional orders of the society.

SOCY 443. THE FAMILY AND SOCIETY (3)
Prerequisite, SOCY 100 or 200. Study of the family as a social institution; its biological and cultural foundations, historic development, changing structure, and function; the interactions of marriage and parenthood, disorganizing and reorganizing factors in present day trends.

SOCY 445. SOCIOLOGY OF THE ARTS (3)
Prerequisite, SOCY 100 or 200. Functions of the arts as a social institution. Social role of the artist. Recruitment to and organizational structure of artistic professions. Art forms and social characteristics of audiences. Changing technology and social values as reflected in artistic expression.

SOCY 447. SMALL GROUP ANALYSIS (3)
Prerequisite, SOCY 100 or 200. Analysis of small group structure and dynamics. Review of research on small groups in factories, military service, schools and communities. Presentation of techniques used in the study of small groups.

SOCY 457. SOCIOLOGY OF LAW (3)
Prerequisite, SOCY 100 or 200. Law as a form of social control; interrelation between legal and other conduct norms as to their content, sanctions, and methods of securing conformity; law as an integral part of the culture of groups; factors and processes operative in the formation of legal norms as determinants of human behavior.

SOCY 460. SOCIOLOGY OF OCCUPATIONS AND CAREERS (3)
Prerequisite, SOCY 100 or 200. The sociology of work and occupational life in modern society. Changing occupational ideologies, values and choices. Occupational status systems and occupational mobility. The social psychology of career success.

SOCY 462. INDUSTRIAL SOCIOLOGY (3)
Prerequisite, SOCY 100 or 200. The sociology of human relations in American industry and business.

Complex industrial and business organization as social systems. Social relationships wthin and between industry, business, community, and society.

SOCY 466. SOCIOLOGY OF POLITICS (3)
Prerequisite, 9 credits of sociology. An introduction to the sociology of political phenomena. Consideration of the basic concepts and major findings in the field; the relationship of the polity to other institutional orders of the society; the relationship of political activity in America to the theory of democracy.

SOCY 470. RURAL-URBAN RELATIONS (3)
Prerequisite, SOCY 100 or 200. The ecology of population and the forces making for change in rural and urban life migration, decentralization and regionalism as methods of studying individual and national issues. Applied field problems.

SOCY 471. THE RURAL COMMUNITY (3)
Prerequisite, SOCY 100 or 200. A detailed study of rural life with emphasis on levels of living, the family, school, and church and organizational activities in the fields of health, recreation, welfare, and planning.

SOCY 473. THE CITY (3)
Prerequisite, SOCY 100 or 200. The rise of urban civilization and metropolitan regions; ecological process and structure; the city as a center of dominance; social problems, control and planning.

SOCY 498. SELECTED TOPICS IN SOCIOLOGY (3)
Prerequisite, SOCY 100 or 200. Topics of special interest to advanced undergraduates in sociology. Such courses will be offered in response to student request and faculty interest. No more than 6 credits may be taken by a student in selected topics.

SOCY 600. SOCIOLOGY METHODOLOGY (3)
Second semester. Logic and method of sociology in relation to the general theory of scientific method; principal issues and points of view.

SOCY 601. ADVANCED STATISTICS FOR SOCIOLOGISTS (3)
Prerequisite, SOCY 401 or equivalent. Advanced treatment of inferential statistics; sampling; research design; nonparametric techniques; scaling.

SOCY 602. INTERMEDIATE PROCEDURES OF DATA ANALYSIS (3)
Prerequisites, undergraduate training in sociological research methods, statistics, and theory or equivalent. This course is designed to provide the graduate student with practical experience in analyzing data. Extensive use of "canned" computer programs is made to analyze available data. Knowledge of computer systems, languages, or applications is not a prerequisite. However, the student is required to have completed an introductory course in research methods and have a basic grasp of multivariate statistics.

SOCY 603. CONTEMPORARY ISSUES IN SOCIOLOGICAL THEORY (3)
Prerequisite, one course in the history of development of sociological theory. Analysis of contemporary schools of sociological theory such as functionalism, positivism, conflict, sociology of knowledge, etc. Examination of issues involved in differing theoretical viewpoints. Study of critical problems involved in a value-free sociology and in the application of sociological knowledge. Assumptions underlying theory construction and present trends in theory development.

SOCY 606. SEMINAR IN FIELD WORK URBAN RESEARCH (3)
Prerequisite, SOCY 623. Methods of research in sociology applied to the urban and metropolitan community; review of needed research; reviews of contemporary research; the design and execution of field studies.

SOCY 609. PRACTICUM IN DATA ANALYSIS IN FIELD RESEARCH (3)
Prerequisite, SOCY 401 and one course in methods. Field training in the conduct of research in an organized research setting. Supervised instruction in the sequence of a total research project including preparation of research design, data collection, data coding, scaling, tabulation, and report writing.

SOCY 618. COMPUTER METHODS FOR SOCIOLOGISTS (3)
Prerequisites, SOCY 400, 401 or equivalents and elementary knowledge of a programming language, CMSC 103, 110 or equivalent and consent of instructor. Designed to present the potential of the computer as a tool in sociological research. Projects involving programming and running of data manipulation techniques, statistical techniques, and simple simulations.

SOCY 620. DEVELOPMENT OF EUROPEAN AND AMERICAN SOCIOLOGICAL THEORY (3)
Prerequisite, SOCY 203 or equivalent. Review of systematic sociological theories (such as Positivism, Organicism, Conflict, etc.) from the early 19th Century to the present. A review of the emerging self-evaluation of sociology.

SOCY 621. SEMINAR—SOCIOLOGICAL THEORY (3)
Prerequisite, SOCY 203 or equivalent. Systematic examination of contemporary sociological theories such as structural functionalism and social action. Special reference is given to the relevance of each theory to the conduct of sociological investigation.

SOCY 622. THE SOCIOLOGY OF KNOWLEDGE (3)
Analysis of the relation of types of knowledge to social structure. Role of social class and social organization in the development of science, political ideology, belief systems and social values. Social roles associated with production of knowledge.

SOCY 623. SURVEY OF URBAN THEORY (3)
Prerequisite, SOCY 120, 473 or equivalent. Theoretical approaches of sociology and other social sciences to urbanism, urbanization, and urban phenomena. Selected approaches: Chicago school; metropolitan region; demography; institutions.

SOCY 624. THEORY OF SOCIAL INTERACTION (3)
Positions of major sociologists and social psychologists as to how the individual interacts with various groups and the issues involved. Trends in recent interaction theory.

SOCY 625. RESEARCH LITERATURE IN SOCIAL STRATIFICATION (3)
Prerequisite, SOCY 441 or equivalent. A comprehensive review and detailed examination of the major theoretical and research problems in the sociology of social stratification. A critical review of the study of social stratification in American sociology. A detailed examination of the forms and functions, and the characteristics, correlates, and consequences of class and status stratification. The distribution of power. The relationship of social stratification to ideology and the institutional orders of the society.

SOCY 626. HUMAN ECOLOGY (3)
Review of research and theory in human ecology. Assessment of the ecological complex (population, organization, environment, technology).

SOCY 630. POPULATION AND SOCIETY (3)
Second semester. Selected problems in the field of population; quantitative and qualitative aspects; American and world problems.

SOCY 631. COMPARATIVE SOCIOLOGY (3)
Second semester, Comparison of the social institutions, organizations, patterns of collective behavior, and art manifestations of societal values of various countries.

SOCY 632. PERSONALITY AND SOCIAL STRUCTURE (3)
Comparative analysis of the development of human nature, personality, and social traits in select social structures.

SOCY 633. SOCIOLOGY OF OCCUPATIONS AND PROFESSIONS (3)
An analysis of the occupational and professional structure of American society, with special emphasis on changing roles, functions, ideologies, and community relationships.

SOCY 634. PUBLIC OPINION AND PROPAGANDA (3)
Processes involved in the formation of mass attitudes; agencies and techniques of communication; quantitative measurement of public opinion.

SOCY 635. SOCIOLOGY OF LAW (3)
Prerequisite· SOCY 457. The interrelationship of legal phenomena with other socio-cultural reality.

SOCY 640. SOCIAL CHANGE AND SOCIAL POLICY (3)
Emergence and development of social policy as related to social change, policy-making factors in social welfare and social legislation.

SOCY 641. FAMILY STUDIES (3)
Case studies of family situations; statistical studies of family trends, methods of investigation and analysis.

SOCY 642. THE SOCIOLOGY OF MENTAL HEALTH (3)
A study of the sociological factors that condition mental health together with an appraisal of the group dynamics of its preservation.

SOCY 643. COMMUNITY STUDIES (3)
Intensive study of the factors affecting community development and growth, social structure, social stratification, social mobility and social institutions; analysis of particular communities.

SOCY 660. THEORIES OF SOCIAL PSYCHOLOGY (3)
Prerequisites, undergraduate training in sociological research methods, statistics, and theory or equivalent. An introduction to some of the theories in social psychology that are particularly useful to sociologists. Topics to be covered include theories of cognitive consistency, social exchange, symbolic interaction, role theory, group processes, and collective behavior.

SOCY 661. THEORIES OF SOCIAL STRATIFICATION (3)
Prerequisites, undergraduate training in sociological research methods, statistics, and theory or equivalent. A critical examination of the major theoretical approaches developed for understandnig societal stratification and social mobility. Consideration will be given to the writings, as well as the pertinent research literature, of Marx, Weber, Parsons, Davis, Moore, Dahrendorf, and Lenski. The works of other theorists, such as Blau and Duncan, Cooley, McClelland, Ossowski, Sorokin, Toennies, and Veblen, will be considered in accordance with the interests of students in the course.

SOCY 662. THEORIES OF FORMAL ORGANIZATION (3)
An introduction to the study of organization, the nature of organizations, types of organizations, determinants and consequences of organizational growth, determinants and consequences of growth for administrative staff, determinants of effectiveness and research in organizations.

SOCY 663. THEORIES OF SOCIAL SYSTEMS (3)
Prerequisite, SOCY 603 or equivalent. Study of systems models—logical, social-psychological and social; types of social systems—ecological, functional, formal, consensual, and historical; levels of social systems—group, complex organization, collectivity and community; methods of study—analytical and empirical, qualitative and quantitative; examples of specific systems—professions, science, politics, cities.

SOCY 699. SPECIAL SOCIAL PROBLEMS (1-16)

SOCY 700. THEORY CONSTRUCTION (3)
Prerequisites, SOCY 603; at least one course each in statistics and research methods (may be undergraduate courses); symbolic logic or philosophy of science. The course will emphasize the logical bases of sociological theories, and will provide practice in the analysis and construction of theories. Topics to be covered include: review of symbolic logic and the meaning of prediction and explanation; the nature of concepts, propositions, and axiomatic systems; the use of models; the nature of causality and causals analysis; fundamental assumptions and variables commonly used in sociological theory. Examples from current sociological theories will be used.

SOCY 701. ISSUES IN QUANTITATIVE METHODS (3)
Prerequisites, SOCY 401 or 601 or equivalent, and instructor's permission. An examination of current issues and problems in the application and interpretation of mathematical and statistical techniques in social research.

SOCY 702. INTERMEDIATE PROCEDURES FOR DATA COLLECTION (3)
Prerequisites, SOCY 602 or equivalent. This will include experimental design and use of quasi-experimental designs; measurement problem; reliability and validity; questionnaire construction; the use of accounting schemes; an introduction to scaling; interviewing; the problem of nonresponse; the processing and coding of data; and the preparation of IBM cards and tapes.

SOCY 799. MASTER'S THESIS RESEARCH (1-6)

SOCY 899. DOCTORAL DISSERTATION RESEARCH (1-8)

SPANISH LANGUAGE AND LITERATURE PROGRAM

Professor and Chairman: Hesse
Professors: Goodwyn, Gramberg, Marra-Lopez, Mendeloff, Nemes
Associate Professors: Rovner, Sosnowski
Assistant Professor: Natella

The Department of Spanish and Portuguese offers graduate programs leading to the degrees of Master of Arts and Doctor of Philosophy in Spanish. The department's offerings are designed to provide the required advanced training in language, literature, and linguistics for achieving professional excellence in high school and college teaching and for undertaking creative research in related fields of inquiry.

Candidates for both the Master of Arts and Doctor of Philosophy degrees may elect to do their work in one of two complementary areas: Spanish literature or Spanish-American literature. Spanish literature embraces four fields: Medieval Literature; The Golden Age; Enlightenment, Romanticism, and Realism; and The Contemporary Period. Spanish-American literature also embraces four fields: Colonial Literature; National Literatures; Modernism; and Present-Day Literature.

In pursuing an M.A. program in Spanish, the student may choose between the two areas mentioned above. Two different programs are available in either area: the thesis program and the non-thesis program.

Minimum requirements in the thesis program are 3 semester hours in teaching techniques (SPAN 605); 3 semester hours in linguistics (SPAN 470 or 610); 18 semester hours in literature, at least 15 of which must be distributed as evenly as possible through the four fields of a single area, and at least 9 of which must be in courses numbered 600 or above; and 6 semester hours of research (SPAN 799), taken while writing a thesis.

Minimum course requirements in the non-thesis program are 3 semester hours in teaching techniques (SPAN 605); 3 semester hours in linguistics (SPAN 470 or 610); and 24 semester hours in literature, at least 21 of which must be distributed as evenly as possible among the four fields of a single area and at least 15 of which must be numbered 600 or above.

As in the M.A. program, the doctoral student may work in either the Spanish or the Spanish-American area. The Ph.D. is a research degree. Coursework taken for the Ph.D is intended as a preparation for the fundamental work of the doctorate, which is the dissertation. The only required courses are in the field of linguistics, where two courses must be taken on the 600-700 level, one of which must be the History of the Spanish Language. Supporting courses may be taken in related fields depending on the dissertation topic.

The department maintains a special research and reference library for graduate students of Spanish in honor of one of its former instructors, the late Pedro F. Entenza.

SPANISH

SPAN 401, 402. ADVANCED COMPOSITION (3, 3)
Exercises in practical stylistics, with special emphasis on idiomatic and syntactic structures. Graduate credit in the College of Education only.

SPAN 404. ORAL PRACTICE FOR NON-NATIVE TEACHERS OF SPANISH (3)
Prerequisite, consent of instructor. Development of fluency in Spanish with stress on correct sentence structure, pronunciation and idiomatic expression. Graduate credit in College of Education only.

SPAN 408, 409. GREAT THEMES OF THE HISPANIC LITERATURES (3, 3)
Pervading themes in the literature of Spain or Spanish-America. Each theme will be announced when the course is offered.

SPAN 410. LITERATURE OF THE MIDDLE AGES (3)
Spanish literary history from the Eleventh through the Fifteenth Century. Reading of representative texts. This course covers until 1350.

SPAN 411. LITERATURE OF THE MIDDLE AGES (3)
Spanish literary history from the Eleventh through the Fifteenth Century. Reading of representative texts. This course covers from 1350 to 1500.

SPAN 412. THE ROMANCERO (3)
Origin, nature and influence. Extensive reading in each of the respective sub-genres.

SPAN 420. 421. PROSE AND POETRY OF THE SIXTEENTH CENTURY (3, 3)
Selected readings and literary analysis.

SPAN 424. DRAMA OF THE SIXTEENTH CENTURY (3)
From the earliest *autos* and *pasos*, the development of Spanish drama anterior to Lope de Vega, including Cervantes.

SPAN 425, 426. SPANISH CIVILIZATION (3, 3)
A survey of two thousand years of Spanish history, outlining the cultural hertiage of the Spanish people, their great men, traditions, customs, art, and literature, with special emphasis on the interrelationship of social and literary history. Conducted in Spanish. Graduate credit in College of Education only.

SPAN 430, 431. CERVANTES—DON QUIXOTE AND NOVELAS EJEMPLARES (3, 3)

SPAN 434. 435. PROSE AND POETRY OF THE SEVENTEENTH CENTURY (3, 3)
Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background.

SPAN 436. DRAMA OF THE SEVENTEENTH CENTURY (3, 3)
Devoted to Lope de Vega, dramatic theory and the Spanish stage.

SPAN 437. DRAMA OF THE SEVENTEENTH CENTURY (3)
Drama after Lope de Vega to Calderon de la Barca and the decline of the Spanish theater.

SPAN 440, 441. LITERATURE OF THE EIGHTEENTH CENTURY (3, 3)
Traditionalism, Neo-Classicism, and Pre-Romanticism in prose, poetry, and the theater; esthetics and poetics of the Enlightenment.

SPAN 446, 447. LATIN-AMERICAN CIVILIZATION (3, 3)
A survey of the cultural heritage of the Latin American peoples from the pre-Columbian period to the present. Hispanic and other European influences. Conducted in Spanish. Graduate credit in College of Education only.

SPAN 448. SPECIAL TOPICS IN LATIN AMERICAN CIVILIZATION (3)
An intensive study of a selected topic related to Latin American civilization. This course may be taken no more than twice. Conducted in Spanish. Graduate credit in College of Education only.

SPAN 452. THE ROMANTIC MOVEMENT IN SPAIN (3)
Poetry, prose and drama of the Romantic and Post-Romantic Periods.

SPAN 454. NINETEENTH CENTURY FICTION (3)
Significant novels of the Nineteenth Century.

SPAN 456. NINETEENTH CENTURY DRAMA AND POETRY (3)
Significant dramas and poetry of the Realistic period.

SPAN 460, 461. THE GENERATION OF 1898 AND ITS SUCCESSORS (3, 3)
Authors and works of all genres of the generation of 1898 and those of the immediately succeeding generation.

SPAN 462. TWENTIETH CENTURY DRAMA (3)
Significant plays of the Twentieth Century.

SPAN 464. CONTEMPORARY SPANISH POETRY (3)
Spanish poetry from the generation of 1927 to the present.

SPAN 466. THE CONTEMPORARY SPANISH NOVEL (3)
The novel and the short story from 1940 to the present.

SPAN 468, 469. MODERNISM AND POST-MODERNISM IN SPAIN AND SPANISH-AMERICA (3, 3)
A study of the most important works and authors of both movements in Spain and Spanish-America.

SPAN 470. APPLIED LINGUISTICS (3)
Nature of applied linguistics and its contribution to the effective teaching of foreign languages. Comparative study of English and Spanish with emphasis upon points of divergence.

SPAN 480. SPANISH-AMERICAN ESSAY (3)
A study of the socio-poltical contents and aesthetic qualities of representative works from the Colonial to the contemporary period.

SPAN 481. SPANISH-AMERICAN ESSAY (3)
A study of the socio-political contents and aesthetic qualities of representative works from the Colonial to the contemporary period, with emphasis on the essay of the Twentieth Century.

SPAN 488, 489. SPANISH-AMERICAN FICTION (3, 3)
Representative novels and/or short stories from the wars of independence to the present or close analysis of major contemporary works. Subject will be announced each time course is offered.

SPAN 491-H. HONORS READING COURSE—POETRY (3)
Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 492-H. HONORS READING COURSE—NOVEL (3)
Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 493-H. HONORS READING COURSE—DRAMA (3)
Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 496-H. HONORS SEMINAR (3)
Required of all students in the honors program. Other students will be admitted on special recommendation. Conducted in Spanish. Discussion of a central theme with related investigation by students.

SPAN 498. SPANISH-AMERICAN POETRY (3)
Main trends, authors and works from the conquest to Ruben Dario.

SPAN 600. READING COURSE FOR MINORS IN SPANISH LITERATURE (3)

SPAN 601. READING COURSE FOR MINORS IN SPANISH LITERATURE (3)

SPAN 602. READING COURSE FOR MINORS IN SPANISH-AMERICAN LITERATURE (3)

SPAN 603. READING COURSE FOR MINORS IN SPANISH-AMERICAN LITERATURE (3)

SPAN 605. TEACHING SPANISH IN INSTITUTIONS OF HIGHER LEARNING (3)
Required of all graduate students, teaching assistants, and new instructors. Instruction, demonstra-

tion, and classroom practice under supervision, of modern procedures in the presentation of first year Spanish.

SPAN 608, 609. MEDIEVAL SPANISH LITERATURE (3, 3)
Specific authors, genres, and literary periods studied in depth.

SPAN 610. THE HISTORY OF THE SPANISH LANGUAGE (3)

SPAN 612. COMPARATIVE ROMANCE LINGUISTICS (3)

SPAN 618, 619. POETRY OF THE GOLDEN AGE (3, 3)
Analyses and studies in depth of specific works of specific poets in the Sixteenth and Seventeenth Centuries.

SPAN 628, 629. SEMINAR—THE GOLDEN AGE IN SPANISH LITERATURE (3, 3)
Specific authors, genres, literary movements and literary periods of the Sixteenth and Seventeenth Centuries studied in depth.

SPAN 699. INDEPENDENT STUDY (1-3)
To provide graduate students an opportunity to pursue independent study under the supervision of a member of the department. Repeatable to a maximum of three credits.

SPAN 708, 709. THE EIGHTEENTH CENTURY (3, 3)
Specific authors, genres, and literary movements studied in depth.

SPAN 718, 719. THE NINETEENTH CENTURY (3, 3)
Specific authors, genres, and literary movements studied in depth.

SPAN 728, 729. THE TWENTIETH CENTURY (3, 3)
Specific authors, genres and literary movements studied in depth.

SPAN 738. THE DRAMA OF THE TWENTIETH CENTURY (3)
Specific authors and movements studied in depth.

SPAN 798. OPEN SEMINAR (3)

SPAN 799. MASTER'S THESIS RESEARCH (1-6)

SPAN 808. COLONIAL SPANISH-AMERICAN LITERATURE (3)
Didactic and narrative prose and epic, dramatic and lyric poetry; principal works and authors.

SPAN 809. COLONIAL SPANISH-AMERICAN LITERATURE (3)
Didactic and narrative prose; dramatic and lyric poetry.

SPAN 818, 819. NATIONAL SPANISH-AMERICAN LITERATURE (3, 3)
Characteristics of the national literatures. Romantic and Costumbrista literature, Gauchismo and Indigenismo. Principal works and authors.

SPAN 828, 829. HISPANIC POETRY OF THE NINETEENTH AND TWENTIETH CENTURIES (3, 3)
Specific authors, genres and literary movements studied in depth.

SPAN 898. OPEN SEMINAR (3)

SPAN 899. DOCTORAL DISSERTATION RESEARCH (1-8)

PORT 478. THEMES AND MOVEMENTS OF LUSO-BRAZILIAN LITERATURE IN TRANSLATION (3)
A study of specific themes and movements in Luso-Brazilian literature, as announced. Designed for students to whom the literature would be inaccessible in Portuguese. Repeatable to six credits.

PORT 699. INDEPENDENT STUDY OF PORTUGUESE (1-3)
To provide graduate students an opportunity to pursue independent study under the supervision of a member of the department.

SPECIAL EDUCATION PROGRAM

Professor and Chairman: Hebeler
Professors: Ashcroft, Simms
Associate Professor: Seidman
Assistant Professor: Jacobs

Graduate studies in the Department of Special Education include programs leading to Master of Arts and Master of Education degrees, Advanced Graduate Specialist certificates, and Doctor of Education and Doctor of Philosophy degrees. Areas of specialization include: integrated special education, educational diagnosis and prescription, mental retardation, education of the gifted, education of the mentally disturbed, and learning disabilities.

Graduate work in special education includes the development of the basic skills necessary for improving instruction of children with learning problems. Graduate study may be used by a student to develop and extend competencies in related areas such as administration and supervision, and educational diagnosis. At advanced graduate study levels programs in teacher education are also available.

Graduate programs are planned individually by the student with his advisor. Each program reflects the individual student's background, his goals and the level of competency being sought. There is no one program of study which all graduate students follow. Individual programming by student and advisor allows wide latitude of career direction within the field of special education upon completion of graduate study.

Prospective graduate students are requested to consult the appropriate document of the following which are available in the College of Education graduate office: Graduate Studies in Education, Statement of Policies and Procedures for the Advanced Graduate Specialist Program in Education, or Statement of Policies and Procedures for Doctoral Degrees in Education.

Graduate study in Special Education requires advanced competencies in the education of children with learning problems. Students without graduate or undergraduate preparation in special education should expect more extensive graduate programs so that they might develop the necessary levels of competence.

Students pursuing the Master's degree program in Special Education may earn the Master of Arts degree

or the Master of Education degree. Specific basic course requirements in Special Education are the same for either program. Students should refer to the Statement of Policies and Procedures for the Master of Arts and Master of Education degrees for differentiation of thesis requirements. The following courses are required for completion of the master's level program: EDMS 446, EDMS 646, and EDHD 721.

The minimum number of graduate hours for the Master's degree program is 30. The student generally takes a minimum of 9 to 15 hours in Special Education. Specific programs and the number of credit hours required will be determined with the student's advisor according to the student's background and career plans.

The Advanced Graduate Specialist certificate in Special Education is available to students wishing to take increased graduate work beyond the Masters level. A student pursuing an A.G.S. certificate in Special Education is required to take the following courses if they have not been part of his Master's program: EDMS 446, EDMS 646, and EDHD 721. The minimum number of graduate hours for the A.G.S. is 60. The core of the program should be made up of Special Education courses and other work within the College of Education or other Colleges of the University as approved by the student's advisor and the Special Education Graduate Faculty.

Students pursuing the doctoral program in Special Education may elect to work for either the Ed.D or Ph.D. degree. A student in the doctoral program will generally complete a minimum of 90 hours of graduate study of which 30-40 hours will be in his major field. A candidate will be expected to develop doctoral level competencies in the declared areas of his professional goals. These goals may include instructional competencies, supervision and administration of special programs, educational diagnosis, teacher education, etc.

EDSP 470. INTRODUCTION TO SPECIAL EDUCATION (3)
Designed to give an understanding of the needs of all types of exceptional children, stressing preventive and remedial measures.

EDSP 471. CHARACTERISTICS OF EXCEPTIONAL CHILDREN—MENTALLY RETARDED (3)
Prerequisite, EDSP 470 or equivalent. Studies the diagnosis, etiology, physical, social and emotional characteristics of exceptional children.

EDSP 472. EDUCATION OF EXCEPTIONAL CHILDREN—MENTALLY RETARDED (3)
Prerequisite, EDSP 471 or equivalent. Offers practical and specific methods of teaching exceptional children. Selected observation of actual teaching may be arranged.

EDSP 473. CURRICULUM FOR EXCEPTIONAL CHILDREN—MENTALLY RETARDED (3)
Prerequisite, EDSP 471 or equivalent. Examines the principles and objectives guiding curriculum for exceptional children; gives experience in developing curriculum; studies various curricula currently in use.

EDSP 475. EDUCATION OF THE SLOW LEARNER (3)
Studies the characteristics of the slow learner and those educational practices which are appropriate for the child who is functioning as a slow learner.

EDSP 481. CHARACTERISTICS OF EXCEPTIONAL CHILDREN—GIFTED (3)
Prerequisite, EDSP 470 or equivalent. Studies the diagnosis, etiology, physical, social, and emotional characteristics of exceptional children.

EDSP 482. EDUCATION OF EXCEPTIONAL CHILDREN—GIFTED (3)
Prerequisite, EDSP 481 or equivalent. Offers practical and specific methods of teaching exceptional children. Selected observation of actual teaching may be arranged.

EDSP 483. CURRICULUM FOR EXCEPTIONAL CHILDREN—GIFTED (3)
Prerequisite, EDSP 481 or equivalent. Examines the principles and objectives guiding current curriculum for exceptional children; gives experience in developing curriculum; studies various curricula currently in use.

EDSP 489. FIELD EXPERIENCE IN SPECIAL EDUCATION (1-4)
Prerequisites, at least six semester hours in special education at the University of Maryland plus such other prerequisites as may be set by the special education department. Planned field experience may be provided for selected students who have had teaching experience and have been approved by the special education faculty. *Note:* The total number of credits which a student may earn in EDSP 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDSP 491. CHARACTERISTICS OF EXCEPTIONAL CHILDREN—PERCEPTUAL LEARNING PROBLEMS (3)
Prerequisite, EDSP 470 or equivalent. Studies the diagnosis, etiology, physical, social, and emotional characteristics of exceptional children.

EDSP 492. EDUCATION OF EXCEPTIONAL CHILDREN—PERCEPTUAL LEARNING PROBLEMS (3)
Prerequisite, EDSP 491 or equivalent. Offers practical and specific methods of teaching exceptional children. Selected observation of actual teaching may be arranged.

EDSP 493. CURRICULUM FOR EXCEPTIONAL CHILDREN—PERCEPTUAL LEARNING PROBLEM (3)
Prerequisite, EDSP 492 or equivalent. Examines the principles and objectives guiding curriculum for exceptional children; gives experience in developing curriculum; studies various curricula currently in use.

EDSP 498. SPECIAL PROBLEMS IN SPECIAL EDUCATION (1-3)
Prerequisite, consent of instructor. Available only to mature students who have definite plans for individual study of approved problems.

EDSP 499. WORKSHOPS, CLINICS, AND INSTITUTES IN SPECIAL EDUCATION (1-6)
The maximum number of credits that may be earned under this course symbol toward any degree is six semester hours; the symbol may be used two or more times until six semester hours have been reached. The following type of educational enterprise may be scheduled under this course heading: workshops conducted by the Special Education Department (or developed cooperatively with other departments, colleges and universities) and not otherwise covered in the present course listing. Laboratories, and special education centers; institutes developed around specific topics or problems and intended for designated groups such as school superintendents, principals and supervisors.

EDSP 600. EXCEPTIONAL CHILDREN AND YOUTH (3)
Prerequisite, 9 hours in special education and consent of instructor. Deals primarily with research relevant to the intellectual, psychological, physical, and emotional characteristics of exceptional children.

EDSP 601. EMOTIONALLY HANDICAPPED CHILDREN AND YOUTH (3)
Prerequisite, EDSP 600 and consent of instructor. Deals with epidemiology, etiology, classification, diagnostic procedures, behavioral characteristics, treatment and prevention of child and adolescent disturbances.

EDSP 605. THE EXCEPTIONAL CHILD AND SOCIETY (3)
Prerequisite, EDSP 600 or consent of instructor. Relationship of the role and adjustment of the child with an exceptionality to societal characteristics.

EDSP 610. ADMINISTRATION AND SUPERVISION OF SPECIAL EDUCATION PROGRAMS (3)
Prerequisite, EDSP 600 and consent of instructor. Consideration of the determination, establishment and function of educational programs to exceptional children for administrative and supervisory personnel.

EDSP 615. EVALUATION AND MEASUREMENT OF EXCEPTIONAL CHILDREN AND YOUTH (3)
Prerequisites, EDMS 446, 646, and EDSP 600. Deals with the understanding and interpretation of the results of psychological and educational tests applicable for use with exceptional children.

EDSP 620. EDUCATIONAL DIAGNOSIS AND PLANNING FOR EXCEPTIONAL CHILDREN AND YOUTH (3)
Prerequisite, EDSP 615. Deals with the identification of learning characteristics of exceptional children and the planning of appropriate programs.

EDSP 621. PSYCHO-EDUCATIONAL PROGRAMMING WITH EMOTIONALLY HANDICAPPED CHILDREN AND YOUTH (3)
Prerequisite, EDSP 600, 601 and consent of instructor. Deals with factors pertinent to therapeutic education of disturbed children and adolescents in special treatment settings.

EDSP 625. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (3)
Prerequisite, 9 hours EDSP including EDSP 600 or consent of instructor. Consideration of the pertinent psychological, educational, medical, sociological and other research and theoretical material relevant to the determination of trends, practices, regarding the mentally retarded.

EDSP 630. PROBLEMS IN THE EDUCATION OF THE GIFTED (3)
Prerequisite, 9 hours EDSP including 600 or consent of instructor. Consideration of the pertinent psychological, educational, medical, sociological and other relevant research and theoretical material relevant to the determination of trends, practices, regarding the gifted.

EDSP 635. PROBLEMS IN THE EDUCATION OF CHILDREN WITH EMOTIONAL DISTURBANCES (3)
Prerequisite, 9 hours EDSP including EDSP 600 or consent of instructor. Consideration of the pertinent psychological, educational, medical, sociological and other research and theoretical material relevant to the determination of trends, practices, regarding the emotionally disturbed.

EDSP 640. PROBLEMS IN THE EDUCATION OF CHILDREN WITH PERCEPTUAL IMPAIRMENT. (3)
Prerequisite, 6 hours in education of the perceptually impaired, EDSP 615 and 620 or consent of instructor. Consideration of the pertinent psychological, educational, medical, sociological and other research and theoretical material relevant to the determination of trends, practices, regarding the perceptually impaired.

EDSP 678. SEMINAR IN SPECIAL EDUCATION (2)

EDSP 798. SPECIAL PROBLEMS IN EDUCATION (1-6)
Master's, AGS, or doctoral candidates who desire to pursue special research problems under the direction of their advisers may register for credit under this number.

EDSP 799. MASTER'S THESIS RESEARCH (1-6)
Six hours registration required for master's thesis.

EDSP 888. APPRENTICESHIP IN SPECIAL EDUCATION (1-9)
Apprenticeships in special education are available to selected students whose application for an apprenticeship has been approved by the special educational faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a Master's Degree in education, and at least six semester hours in special education at the University of Maryland. *Note:* The total number of credits which a student may earn in EDSP 489, 888 and 889 is limited to a maximum of 20 semester hours.

EDSP 889. INTERNSHIP IN SPECIAL EDUCATION (3-16)
Internships in special education are available to se-

lected students who have teaching experience. The following groups of students are eligible: (a) any student who has been advanced to candidacy for the Doctor's Degree; and (b) any student who receives special approval by the special education faculty for an internship, provided that prior to taking an internship, such student shall have completed at least 60 semester hours of graduate work, including at least six semester hours in education at the University of Maryland. Each intern is assigned to work on a full-time basis for at least a semester with an appropriate staff member in a cooperating school, school system, or educational institution or agency. The internship must be taken in a school situation different from the one where the student is regularly employed. The intern's sponsor maintains a close working relationship with the intern and the other persons involved. *Note:* The total number of credits which a student may earn in EDSP 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDSP 899. DOCTORAL DISSERTATION RESEARCH (1-8)
Six to nine hours required for an Ed.D. project and 12-18 hours required for a Ph.D. dissertation.

SPEECH AND DRAMATIC ART PROGRAM

Professor and Acting Chairman: Linkow
Professors: Aylward, Pugliese
Associate Professors: Kirkley, Meersman, O'Leary, Vaughan, Weiss, Wolvin
Assistant Professors: Falcione, Jamieson, Kolker, Onder

The Department of Speech and Dramatic Art offers the Master of Arts degree under thesis or non-thesis options in each area of the department: dramatic arts, radio-television-film, and speech communication. In the thesis option, an oral defense pertaining to the thesis is required of all candidates. In the non-thesis option, thirty hours of coursework is required. In addition, a formal research paper and comprehensive examinations are required.

The department cooperates with the Department of Secondary Education in offering the Doctor of Philosophy degree in speech education.

Departmental requirements supplementary to the Graduate School requirements have been formulated in each of the areas for the guidance of students. Within each area opportunities for typical specialization exist. Copies of the program objectives and requirements may be obtained from the Department.

DRAMATIC ART

DART 420. STYLES AND THEORIES OF ACTING (3)
Prerequisite, DART 120 or consent of instructor. The study and application of historical styles and theories of acting.

DART 430. PLAY DIRECTING (3)

DART 440. CHILDREN'S DRAMATICS (3)
Principles and methods necessary for staging children's productions on the elementary school level. Major emphasis on creative dramatics, the application of creative dramatics in the schoolroom, and the values gained by the child in this activity. Students will conduct classes in formal and creative dramatics which will culminate in children's programs. For dramatic art majors only.

DART 451. ADVANCED SCENIC DESIGN (3)
Prerequisite, DART 330, 375, 480 or permission of instructor. Design of stage settings, and of one total production. Study of stage design of the main historical periods and in the contemporary theatre.

DART 476. PRINCIPLES AND THEORIES OF STAGE LIGHTING (3)
Prerequisite, DART 375. A study of composition, control, and instrumentation in theatrical lighting.

DART 479. THEATER WORKSHOP (3)
Prerequisite, DART 120 or 170. A laboratory course designed to provide the student with practical experience in all phases of theatre production.

DART 480. STAGE COSTUMING I (3)
Prerequisite, DART 252. Basic principles of stage costuming.

DART 481. STAGE COSTUMING II (3)
Prerequisite, DART 480. The advanced study of stage costuming through the development of style as a design consideration in theatrical productions. Designing costumes for various forms of drama, including period-styles.

DART 490. HISTORY OF THE THEATER (3)
A survey of dramatic production from early origin to 1800.

DART 491. HISTORY OF THE THEATER (3)
A survey of dramatic production from 1800 to the present.

DART 499. SEMINAR (3)
Prerequisites, senior standing and consent of instructor. Present-day drama research.

DART 600. INTRODUCTION TO GRADUATE STUDY IN THEATRE (3)

DART 669. INDEPENDENT STUDY (1-3)

DART 678. THEORY OF VISUAL DESIGN FOR THE PERFORMING ARTS (3)
Prerequisite, DART 375 or consent of instructor. An historical and theoretical study of design practices in the performing arts.

DART 688. SPECIAL PROBLEMS IN DRAMA (3)
The preparation of adaptations and other projects in dramaturgy.

DART 689. THEORIES OF THE DRAMA (3)
Advanced study of the identification and development of dramatic form from the early Greek drama to contemporary forms; the aesthetics of theatre arts; and dramatic criticism.

DART 698. SEMINAR—STUDIES IN THEATRE (3)
Research projects adapted to individual backgrounds and special work.

DART 699. THE THEORY OF PRE-MODERN DRAMATIC PRODUCTION (3)
An historical survey of production styles.

DART 799. MASTER'S THESIS RESEARCH (1-6)

SPEECH

SPCH 400. INTRODUCTION TO RESEARCH METHODOLOGIES IN SPEECH COMMUNICATION (3)
Prerequisite, speech communication major or minor or consent of the instructor. An introductory survey of empirical and historical-critical research methodologies in speech communication. The course is designed to prepare the student to understand and to conduct basic research in the field.

SPCH 420. ADVANCED GROUP DISCUSSION (3)
Prerequisite, SPCH 220 or consent of the instructor. An examination of current research and techniques in the discussion and conference, including extensive practice in various types of discussions. Emphasis is upon small group leadership and dynamics.

SPCH 422. INTERVIEWING (3)
Prerequisite, permission of instructor. Speech principles and practices basic to recognized types of interview, giving special attention to behavioral objectives and communication variables involved in the process of interviewing.

SPCH 423. COMMUNICATION PROCESSES IN CONFERENCES (3)
Prerequisite, one course in speech communication or consent of the instructor. Group participation in conferences, methods of problem solving, semantic aspects of language, and the function of conferences in business, industry and government settings.

SPCH 424. BUSINESS, INDUSTRIAL AND GOVERNMENT COMMUNICATION (3)
Prerequisite, permission of the instructor. Structure, methodology and application of communication theory in the industrial setting will be emphasized.

SPCH 440. ADVANCED ORAL INTERPRETATION (3)
Prerequisite, SPCH 240. A study of the advanced theories and techniques employed in the interpretation of prose, poetry and drama. Attention is given to selections, analyses, cuttings, script compilations, and the planning of programs and performances in oral interpretation.

SPCH 441. READERS THEATRE (3)
Prerequisite, SPCH 240 or consent of the instructor. Theories and techniques of Readers Theatre will be analyzed to enhance the interpreting and directing abilities of students. Special attention will be given to interpretation and direction of prose, drama, and script compilation.

SPCH 450. CLASSICAL AND MEDIEVAL RHETORICAL THEORY (3)
Prerequisite, SPCH 200 or consent of instructor. The theories of speech-making and speech composition as propounded by the classical rhetoricians. Special attention is given to Plato, Aristotle, Socrates, Cicero, Quintilian, and St. Augustine.

SPCH 451. RENAISSANCE AND MODERN RHETORICAL THEORY (3)
Prerequisite, SPCH 200 or consent of the instructor. A study of the development of modern rhetorical theories in Europe and America with consideration of the application of the theories to public address. Special attention is given to Thomas Sheridan, John Walker, George Campbell, Hugh Blair, Richard Whately, James A. Winans, Charles Woolbert, I. A. Richards, and Kenneth Burke.

SPCH 455. SPEECHWRITING (3)
Prerequisite, SPCH 200 or consent of the instructor. Intensive study of rhetorical principles of speech composition through study of model speeches and through a practicum in speech writing. Emphasis will be placed on the application of research in speech writing to various forms and styles of speeches.

SPCH 460. AMERICAN PUBLIC ADDRESS 1635-1900 (3)
Prerequisite, SPCH 200 or consent of the instructor. Course examines the rhetorical development of major historical movements and influential spokesmen from 1635-1900. Emphasis on the Reign of Theocracy, the American Revolution, the Presidential Inaugural as a rhetorical type, the Compromise of 1850, the Lincoln-Douglas debates, the Civil War rhetoric and the Populist movement.

SPCH 461. AMERICAN PUBLIC ADDRESS IN THE 20TH CENTURY (3)
Prerequisite, SPCH 200 or consent of instructor. Course examines the rhetorical development of major historical movements and influential spokesmen from 1900 to the present. Focus on the progressive movement, the rise of labor, women's suffrage, McCarthyism and the evolution of pro- and anti-war rhetoric.

SPCH 462. BRITISH PUBLIC ADDRESS (3)
Prerequisite, SPCH 200 or consent of the instructor. A biographical, textual and critical-rhetorical study of great British speakers and their influences. Special attention will be devoted to the 'Golden Age' of British oratory and to the forms and styles of contemporary speakers.

SPCH 470. MATERIALS AND PROGRAMS FOR THE DEVELOPMENT OF LISTENING (3)
The study of research findings, listening tests, materials, equipment, and programs which can be used to develop listening skills.

SPCH 474. COMMUNICATION THEORY AND PROCESS (3)
A general survey of introductory material in communication theory.

SPCH 475. PERSUASION IN SPEECH (3)
Prerequisite, SPCH 200 or 230. A study of the bases of persuasion with emphasis on recent experimental developments in persuasion.

SPCH 476. FOUNDATIONS OF SPEECH BEHAVIOR (3)
This course will provide a study of the acquisition of speech, the elements that influence speech behavior, the influences of speech behavior, and a

theoretical framework for the analysis of communication situations. Students will apply the theory to analysis of specific communication situations.

SPCH 488. SPEECH COMMUNICATION INTERNSHIP (1-6)
Registration by permission of adviser only. This independent internship is designed to give the speech communication student practical career experience with a speech communication professional in the Washington metropolitan area. Limited to a maximum of six credits.

SPCH 489. SPEECH COMMUNICATION WORKSHOP (1-6)
Workshops devoted to special, in-depth study in speech communication. Course may be repeatable to a maximum of six semester hours.

SPCH 498. SEMINAR (3)
Prerequisites, senior standing and consent of instructor. Present-day speech research.

SPCH 499-H. HONORS SEMINAR (3)
Readings, symposiums, visiting lectures, discussions.

SPCH 600. EMPIRICAL RESEARCH IN SPEECH COMMUNICATION (3)

SPCH 601. HISTORICAL-CRITICAL RESEARCH IN SPEECH COMMUNICATION (3)
Intense study in critical and historical methodology as applicable to research in speech communication. Emphasis will be placed on the composition and the evaluation of historical-critical studies of significance in the field of rhetorical communication scholarship.

SPCH 680. SPEECH AND DRAMA PROGRAMS IN HIGHER EDUCATION (3)
A study of current theories and practices in speech education.

SPCH 698. SPECIAL PROBLEMS IN SPEECH COMMUNICATION (3)

SPCH 720. SEMINAR IN SMALL GROUP COMMUNICATION (3)
The seminar will explore the variables involved in small group communication (formation and membership, leadership, functions, and current research problems). The focus of the course will be two-fold: (1) to give the student a survey of small group communication theory, and (2) to provide some in-depth analysis of current problems in small group communication.

SPCH 724. SEMINAR IN ORGANIZATIONAL COMMUNICATION (3)
Prerequisite, permission of the instructor. Theories and problems of human communication within, between, and/or among formal organizations will be emphasized.

SPCH 755. SEMINAR IN RHETORICAL THEORY (3)
Prerequisite, SPCH 460, 461 or 450. Examination of selected theories of style drawn from the fields of rhetoric and literature, and analysis of model speeches.

SPCH 760. SEMINAR IN POLITICAL COMMUNICATION (3)
Prerequisite, SPCH 601 or consent of the instructor. A blend of theory and practice to integrate rhetorical-critical theory and empirical methods with politics. Practitioners in political communication will be drawn in as resource persons. Students will map the communication strategy for candidates and analyze actual campaign strategies.

SPCH 762. SEMINAR IN PUBLIC ADDRESS (3)
An in-depth study of national and international speakers and issues throughout the history of the spoken word. Emphasis will be placed upon the application of rhetorical principles to the analysis of world speakers and their speeches.

SPCH 775. SEMINAR IN PERSUASION AND ATTITUDE CHANGE (3)
This seminar will concentrate on the problem of making message strategy decisions. Course content will consist of study of both theoretical and empirical research on attitude and attitude change in persuasive communication.

SPCH 776. INTERPERSONAL COMMUNICATION (3)
Problems and processes of symbolic representation in speech, the effects of language on communication, semantic redundancy, and interaction between meaning and the structure of oral language.

SPCH 798. INDEPENDENT STUDY (1-3)
Prerequisite, consent of instructor. An individual course designed for intensive study or research of problems in any one of the three areas of drama, general speech, or radio/TV.

SPCH 799. MASTER'S THESIS RESEARCH (1-6)

RADIO-TELEVISION-FILM

RTVF 411. SEMINAR (3)
Prerequisites, senior standing and consent of instructor. Present day radio-television-film research.

RTVF 413. THE HISTORY OF THE FILM (3)
An advanced survey of the film as an art form. Cinema pre-history, actualities and the lumiere tradition, Melies, Griffith, and their contemporaries, the silent film (1920-29); Germany, Russia, and the U.S.A., screen comedy, the sound film (1926-present); American and foreign master directors, recent and current trends. Recommended prior to this course: RTVF 314.

RTVF 414. CONTEMPORARY AMERICAN CINEMA (3)
An analysis of trends and major social issues in American culture as they are expressed through the film medium. Emphasis on "New Wave," experimental, underground, independent, and cinema Verite motion pictures.

RTVF 415. CONTEMPORARY EUROPEAN CINEMA (3)
A comparative and critical analysis of the European motion picture both as a distinct art form reflecting the national character of a particular country and as a medium for mass communications demonstrating the universality of the human condition.

RTVF 417. DRAMATIC WRITING FOR BROADCASTING AND FILM (3)
Prerequisite, RTVF 317 or consent of instructor. An introduction to the principles, methods and limitations of writing comedy, drama, and the documentary for radio, television, and film.

RTVF 420. THE DOCUMENTARY FILM (3)
Growth, implication, and the use of the international nonfiction film as propaganda, public service, promotion, education, and entertainment. Case studies from representative documentaries will be analyzed.

RTVF 425. TELEVISION AND POLITICS (3)
Critical review of studies of the effects of political broadcasts; legal and social issues; surveys and media campaigns.

RTVF 440. TELEVISION DIRECTION (3)
Two-hour lecture, two-hour laboratory. Prerequisite, RTVF 340. Principles of television direction, including analysis of script, casting, rehearsing, production, audio and video control.

RTVF 449. TELEVISION WORKSHOP (3)
Two-hour lecture, four-hour laboratory. Prerequisites, RTVF 340, 440 and consent of instructor.

RTVF 450. RADIO AND TELEVISION STATION MANAGEMENT (3)
The role of the manager in the modern broadcasting industry. Station communication factors, regulation, licensing, personnel functions, sales, programming supervision, audience analysis, and station promotion.

RTVF 451. BROADCAST CRITICISM (3)
An analysis of the professional, historical, social, and psychological criticism of American radio and television, together with practical application of professional and scholarly critical methods.

RTVF 452. INTERNATIONAL AND COMPARATIVE BROADCASTING SYSTEMS (3)
A comparative study of international broadcasting program policies, economic systems, control and organization. The use of broadcasting in international affairs as an instrument of propaganda, culture and information dissemination. Monitoring of overseas broadcasts, television programs and discussions with representatives of domestic and foreign international broadcast agencies.

RTVF 453. BROADCASTING AND GOVERNMENT (3)
Legal issues involving radio and television: freedom, restraints, self-regulation; regulation of programming, competition, rights as seen by the broadcaster, regulatory agencies and the public.

RTVF 465. ADVANCED FILM PRODUCTION (3)
Prerequisite, RTVF 355 and consent of instructor. Consideration of film technique and theory as they apply to the making of a full-length motion picture.

RTVF 600. INTRODUCTION TO GRADUATE STUDY IN BROADCASTING (3)

RTVF 640. ADVANCED TELEVISION DIRECTION (3)
Prerequisite, RTVF 440 or consent of instructor. Principles of television direction as applied to dramatic programs, together with a consideration of the specific aesthetic values of the television medium.

RTVF 648. SEMINAR IN BROADCASTING (3)
Studies of various aspects of broadcasting. Subject matter changed each semester.

RTVF 649. SPECIAL PROBLEMS IN BROADCASTING (3)
An experimental course for the development of new ideas in broadcasting.

RTVF 699. INDEPENDENT STUDY (1-3)

RTVF 799. MASTER'S THESIS RESEARCH (1-6)

TEXTILES AND CONSUMER ECONOMICS PROGRAM

Professor and Chairman: Smith
Professor: Dardis
Visiting Professor: Fourt
Associate Professor: Buck
Visiting Associate Professor: Clark
Assistant Professors: Block, Hacklander, Spivak
Visiting Assistant Professor: Yeh

The Department of Textiles and Consumer Economics offers graduate work leading to the Master of Science degree in either the thesis or the nonthesis option. Fields of specialization are textiles and consumer economics. In the field of textiles, students may concentrate in clothing and human behavior, historic textiles and costume, textile economics and marketing, and textile science. In consumer economics, students may work in consumption economics or consumer behavior.

There are no rigid course requirements for admission to the graduate program in Textiles and Consumer Economics. A major in Home Economics, Consumer Economics, Textiles and Clothing, Textiles, or a relevant discipline such as chemistry, economics, or psychology is acceptable as background for study in this field. Preparation in the basic physical and social sciences (chemistry, mathematics, economics, psychology, and sociology) is highly recommended. All applicants are required to submit scores of the Graduate Record Examination Aptitude Test.

Additional information about the graduate program may be obtained from the Department of Textiles and Consumer Economics.

CONSUMER ECONOMICS

CNEC 431. THE CONSUMER AND THE LAW (3)
Three lectures a week. A study of legislation affecting consumer goods and services. Topics covered include product safety and liability, packaging and labeling, deceptive advertising, and consumer credit. The implications of such legislation for consumer welfare with particular emphasis on the disadvantaged groups in our society will be examined.

CNEC 435. ECONOMICS OF CONSUMPTION (3)
Three lectures per week. Prerequisites, ECON 201 and 203 or ECON 205 for non-majors. The application of economic theory to a study of consumer decision-making and its role in a market economy at both the individual and aggregate levels. Topics covered include empirical studies of consumer spend-

ing and saving, the consumer in the market and collective consumption.

CNEC 437. CONSUMER BEHAVIOR (3)
Three lectures per week. Prerequisites, PSYC 100 and SOCY 100. An application of the behavioral sciences to a study of consumer behavior. Current theories, models and empirical research findings are explored.

CNEC 498. SPECIAL STUDIES (2-4)
Independent study by an individual student or by a group of students in advanced work not otherwise provided in the department. Students must prepare a description of the study they wish to undertake. The plan must be approved by the faculty directing the study and the department chairman.

TEXTILES

TEXT 420. APPAREL DESIGN—DRAPING (3)
Two 3-hour laboratory periods per week. Prerequisites, APDS 101 and TXAP 222. APDS 220 recommended but not required. Students explore pattern design through draping on the human form. Emphasis is on the interrelationship between material, design and form.

TEXT 425. APPAREL DESIGN—EXPERIMENTAL PROCESSES (3)
Two 3-hour laboratory periods per week. Prerequisites, APDS 101, TEXT 250, and TXAP 222. Processes are related to fiber and fabric characteristics, style and end-use. Opportunities are provided for students to: 1. learn advanced construction and tailoring techniques, 2. explore, adapt and create new processes with modern textile materials, 3. evaluate results in terms of design quality.

TEXT 441. CLOTHING AND HUMAN BEHAVIOR (3)
Three lectures per week. Prerequisites, PSYC 100 and SOCY 100. An exploration of socio-psychological approaches to the study of clothing in relation to human behavior. Social and psychological theories will be examined as possible framework for the study and investigation of clothing.

TEXT 445. HISTORY OF COSTUME I (3)
Three lectures per week. The wrap-style dress. A critical study of the various forms of dress; analyzing shape and form of garments and the component parts of which they are made, taking special note of the distinctive styles and unique shapes which help distinguish one period from another; relating the history of costume to events, to achievements, to the social attitudes and development of the various times and cultures of man.

TEXT 447. HISTORY OF COSTUME II (3)
Three lectures per week. The shaped-style dress. A critical study of the various forms of dress; analyzing shape and form of garments and the component parts of which they are made, taking special note of the distinctive styles and unique shapes which help distinguish one period from another; relating the history of costume to events, to achievements, to the social attitudes and development of the various times and cultures of man.

TEXT 452. TEXTILE SCIENCE—CHEMICAL STRUCTURES AND PROPERTIES OF FIBERS (3)
Two lectures and one 3-hour laboratory per week. Prerequisites, CHEM 104 or consent of instructor. The chemical structure, properties and reactions of the major classes of natural and man-made fibers. Emphasis is placed upon the relationship between molecular structure and physical properties of fibers and fabrics. Laboratory includes chemical identification of fibers, preparation of selected fibers and examination of chemical reactions and properties of fibers.

TEXT 454. TEXTILE SCIENCE—FINISHES (3)
Two lectures and one 3-hour laboratory per week. Prerequisite, TEXT 452 or consent of instructor. A study of the chemical reactions and any mechanisms involved in imparting water repellence, crease resistance and crease recovery properties, shrink-resistance, flame resistance, soil-release properties, and moth and mildew resistance to textile materials. Properties of the finished material which affect its end-use wil also be examined. Laboratory work includes the application of finishes, identification of finishes and a study of the properties of finished fabrics.

TEXT 456. TEXTILE SCIENCE—CHEMISTRY AND PHYSICS OF FIBERS AND POLYMERS (3)
Two lectures and one 3-hour laboratory per week. Prerequisite, consent of instructor. Theory of fiber structure and its relationship to chemical and physical properties of natural and man-made fibers. Laboratory includes study of performance of textile materials in relation to their chemical and physical properties.

TEXT 463. HISTORY OF TEXTILES (3)
Three lectures per week. Prerequisite, TEXT 150 or consent of instructor. A study of historic and contemporary fibers and fabrics. Emphasis will be placed on the analysis of designs and techniques of decorating fabrics and the relationship of textiles to the aesthetic and developmental cultures of society.

TEXT 465. ECONOMICS OF THE TEXTILE AND APPAREL INDUSTRIES (3)
Three lectures per week. Prerequisites, ECON 201 and 203. Trends in the production and consumption of textiles and apparel; economic analysis of the textile and apparel industries; factors affecting changes in output, price, location and market structure.

TEXT 498. SPECIAL STUDIES (2-4)
Independent study by an individual student or by a group of students in advanced work not otherwise provided in the department. Students must prepare a description of the study they wish to undertake. The plan must be approved by the faculty directing the study and the department chairman.

TEXTILES AND CONSUMER ECONOMICS

TXCE 608. SPECIAL PROBLEMS (1-3)
Credit according to time scheduled and organization of the course. The course may be organized as a lecture series on a specialized advanced topic or may consist of an experimental problem other than the student's thesis topic. Maximum credit allowed

toward an advanced degree shall not exceed six hours.

TXCE 638. SELECTED TOPICS IN CONSUMER BEHAVIOR (2-3)
Readings and discussion on selected topics in consumer behavior. The focus is on the application of social sciences to a study of consumer decision processes. Course may be taken for a maximum of six credits.

TXCE 639. SEMINAR IN THE ECONOMICS OF CONSUMPTION (3)
A critical examination of current theories and research in the field. The application of research methods to current problems in consumption economics will be discussed. Course may be taken for a maximum of six credits.

TXCE 648. SEMINAR IN HISTORIC TEXTILES (1-3)
In depth studies of selected areas of historic textiles and/or historic textile products, together with their relationships to the cultures and societies of man. Maximum credit allowed toward an advanced degree shall not exceed six hours.

TXCE 649. SEMINAR IN CLOTHING AND HUMAN BEHAVIOR (3)
An examination of theories and research concerned with the relation between clothing and human behavior. Special emphasis will be placed on research techniques. Maximum credit allowed toward an advanced degree shall not exceed six hours.

TXCE 650. SEMINAR IN TEXTILE ECONOMICS AND MARKETING (3)
A critical review of research literature in the economics of the textile and apparel industries and the marketing of textile products. The application of research methods to current problems of the textile and apparel industries will be discussed.

TXCE 658. ADVANCED TOPICS IN TEXTILE SCIENCE (2-3)
An examination of the structure, properties and performance of textile materials. Topic and credit will be announced. Course may be taken for a maximum of six credits.

TXCE 659. SEMINAR IN TEXTILE SCIENCE (1-3)
A critical discussion of current research literature in the field.

TXCE 799. MASTER'S THESIS RESEARCH (1-6)

URBAN STUDIES COURSES

URBS 430. PRACTICUM IN THE URBAN COMMUNITY AND URBAN ORGANIZATIONS (3)
Supervised field training in urban-oriented programs. Areas of interest emphasized are: (1) neighborhoods and commmunities, (2) organizations and agencies, (3) specific programs. The student will be assigned to a specific agency or project and will be responsible to that agency. Class meetings, written reports, instructor conferences, and a student's critique of his experience are included.

URBS 480. URBAN THEORY AND SIMULATION (3)
Review of early theories of the city. Contemporary theories of the city as a physical and an institutional system. Urban theory as integration of information involving economic, political, and social dimensions of contemporary cities. Simulation and gaming as theory testing; urban simulation and gaming as theory building.

URBS 601. FIELDS AND PROBLEMS OF URBAN STUDIES (3)
Three urban interdisciplinary emphasis—environmental, institutional, and historical-cultural—concept of the metropolis in the United States; major theoretical research interests in urban affairs. Social problems of urbanization in the United States; trends in governmental intervention into urban conditions; emergence of urban-related occupations and careers; relations of emerging metropolises to society.

URBS 610. RESEARCH METHODS IN URBAN STUDIES (3)
Assumes a knowledge of conventional techniques of investigation—interview, questionnaire, survey research, use of documentary sources. Emphasis on learning creative approaches and on training for innovative uses of research techniques—simulation and gaming of decision-making, field study of environmental-societal influences, computer modeling of urban information. Individual and team approaches.

URBS 640. ECOLOGY AND DEMOGRAPHY OF URBAN SYSTEMS (3)
Analysis of land-use patterns and demographic characteristics. Examination of changes in these relations and their influence on institutional structures. Study of dynamics of transactions and flows between localities. Metropolises as examples of exchange systems. Problems in indicator development which define the demographic and ecological characteristics. Policy implications of data banks based on indicator information. Social indicators for metropolises as predictors of future development.

URBS 680. THEORY OF URBAN SYSTEMS (3)
Theories and predictions of economic, social, and political trends of American cities; evidence of an emerging megalopolis; ideological issues for interpreting increasing urbanization; relation between urban theory and policies; bases of present urban policies; necessity of more adequate urban data for theory building; research priorities.

URBS 685. RECENT DEVELOPMENT IN URBAN STUDIES (3)
Examination of a selected current aspect of the rapidly evolving field of urban affairs. Examples might include urban population trends revealed by the 1970 Census, evaluation of the Model Cities program, developments in legislation, programs concerning the urban environment, developments in urban crime programs, "new towns" in the United States, applications of urban simulation and gaming, and developments in metropolitan and regional government.

URBS 698. INDEPENDENT STUDY IN URBAN TOPICS (3)
Directed research and study of selected aspects of urban affairs.

URBS 799. MASTER'S THESIS RESEARCH

ZOOLOGY PROGRAM

Professor and Chairman: Corliss
Professors: Anastos, Brinkley, Brown, Clark, Grollman, Haley, Highton, Jachowski, Ramm, Schleidt
Associate Professors: Barnett, Contrera, Goode, Imberski, Levitan, Linder, Morse, Pierce, Potter, Small
Assistant Professors: Allan, Gill, Golmon, Morton, Rees, Vermeij, Woodin
Research Professors: Eisenberg, Flyger, Otto

The Department of Zoology offers programs of study leading to the degrees of Master of Science (thesis and non-thesis) and Doctor of Philosophy with specialization in the following fields: cell biology, developmental biology, estuarine and marine biology, genetics, parasitology, physiology, systematic and evolutionary biology, behavior, invertebrate zoology, endocrinology, ecology.

Admission to graduate study in the Department of Zoology is restricted to students with an adequate undergraduate preparation in physical as well as biological sciences, including upper division courses in zoology and courses in mathematics (through one year of calculus), statistics, physics, and chemistry through organic. Able students who lack preparation in a particular area may be admitted provided that the deficiency is corrected early in the graduate work. Graduate Record Examinations are recommended but are not required.

Students are urged to communicate directly with the faculty in the area of their interest but additional general information and a statement of departmental requirements supplementing those of The Graduate School may be obtained by writing to the Director of Graduate Studies, Department of Zoology, University of Maryland, College Park, Md. 20742.

ZOOL 411. CELL BIOLOGY (4)
Two lectures, one 1-hour demonstration-discussion period and one three-hour laboratory period a week. Prerequisites, two years of zoology and a year of organic chemistry, or permission of the instructor. A study of cell structure and function with an emphasis on the activity of subcellular organoids and the mechanisms of coordination and control of cell function. (Brown)

ZOOL 413. BIOPHYSICS (3)
Three lectures a week. Prerequisites, one year of biology, a year of physics, and at least one semester of calculus; or permission of the instructor. An introduction to the ideas and methods used in biophysics to analyze the functional components of cells and tissues as physical-chemical systems. (Goode)

ZOOL 415. CELL DIFFERENTIATION (3)
Three lectures per week. Prerequisites, a course in embryology, cell biology, or genetic systems, or permission of the instructor. A discussion of cellular and subcellular differentiation, emphasizing the biochemical and ultrastructural bases of these development changes. (Goode)

ZOOL 421. VERTEBRATE PHYSIOLOGY (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, one year of zoology and one semester of organic chemistry. An intensive study of nerve, muscle, sensory receptors and the central nervous system. (Levitan)

ZOOL 422. VERTEBRATE PHYSIOLOGY (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, one year of zoology and one semester of organic chemistry. An intensive study of the cardiovascular, gastrointestinal, renal, and respiratory systems, and an introduction to endrocrinology, basal metabolism and reproductive physiology. (Contrera)

ZOOL 426. GENERAL ENDOCRINOLOGY (3)
Three lectures each week. Prerequisites, one year of zoology and one semester of organic chemistry. The study of the functions an the functioning of the endocrine organs of animals, with special reference to the vertebrates. (Brinkley)

ZOOL 430. VERTEBRATE EMBRYOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology, principles of developmental dynamics including organization, differentiation, morphogenesis, and developmental physiology. (Ramm)

ZOOL 440. EVOLUTION (3)
Three lectures per week. Prerequisite, a course in genetics or permission of instructor. A consideration of current thought in regard to the origin and evolution of living organisms. (Highton)

ZOOL 446. MOLECULAR GENETICS (3)
Three lectures per week. Prerequisites, a course in genetics and one year of organic chemistry. The molecular basis of gene structure and function. Regulation of differential gene expression. (Imberski)

ZOOL 447. EXPERIMENTAL GENETICS (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, two courses in genetics, one of which included laboratory work, and permission of instructor. A methodology and techniques course considering experimental design, the use of diverse organisms and instrumentation and the presentation and interpretation of data.

ZOOL 460. ETHOLOGY (3)
Three lectures per week. Prerequisite, a course in general zoology and a course (or current enrollment) in physiology. An introduction to the principles of animal behavior with emphasis on physiological bases, ecological correlates and evolutionary aspects of behavior.

ZOOL 461. ETHOLOGY LABORATORY (3)
One lecture and two three-hour laboratory periods per week. Prerequisite or corequisite, ZOOL 460 or equivalent. Training in the description of behavior, methods of quantification and experimentation, and the mathematical treatment of behavioral data.

ZOOL 470. ADVANCED ANIMAL ECOLOGY (2)
Two lectures per week. Prerequisites, one year of zoology, calculus, and statistics. Designed for majors and graduate students in the biological sciences. Topics include theory of population growth and regulation, life tables and population projection matrices, niche theory, theory of competition and predation, diversity analysis, and energetic modelling.

Emphasis will be on current literature and research in ecological theory.

ZOOL 471. LABORATORY AND FIELD ECOLOGY (2)
One three-hour session for exercises, and 1 one-hour discussion. Prerequisites, ZOOL 470 previously or concurrently. Exercises in laboratory and field will pursue problems of contemporary ecological interest; population density regulation, community structure, niche shape, competition coefficients, pattern diversity, and energetics of ecosystems. Topics will be coordinated with those presented in ZOOL 470. Terrestrial and aquatic systems will be studied.

ZOOL 472. PROTOZOOLOGY (4)
Basic conceptual treatment of free-living and parasitic protozoan functional morphology, life history, and systematics. The laboratory will stress observations of protozoa, living and stained, collected from diverse habitats. Two hours of lecture and six hours of laboratory including fields trips. Prerequisite, one year of biology. (Small)

ZOOL 475. GENERAL PARASITOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, two years of zoology and one year of chemistry, or permission of the instructor. A consideration of the phenomenon of parasitism through a study of the structure, function and host relationships of parasitic organisms. (Jachowski)

ZOOL 480. AQUATIC BIOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, an introductory course in ecology and one semester of chemistry. An investigation of the causal relationships of fresh water, estuarine and marine biotic communities to their environments. (Rees)

ZOOL 481. THE BIOLOGY OF MARINE AND ESTUARINE INVERTEBRATES (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology. An in depth consideration of the taxonomy and functional morphology of the invertebrates, exclusive of insects. Chesapeake Bay forms and the study of living material will be emphasized. (Pierce)

ZOOL 482. MARINE VERTEBRATE ZOOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, two years of zoology or permission of the instructor. A consideration of the evolution, taxonomy, morphology, physiology, behavior and ecology of marine and estuarine protochordates and vertebrates. (Clark)

ZOOL 483. VERTEBRATE ZOOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology or permission of the instructor. The identification, classification, habits, and behavior of vertebrates with emphasis on fresh water, terrestrial and aerial forms, and a consideration of the evolution of living and fossil representatives. (Morse)

ZOOL 495. MAMMALIAN HISTOLOGY (4)
Two lectures and two three-hour laboratory periods per week. Prerequisites, a course in general zoology and a course in vertebrate anatomy, or permission of the instructor. A study of the microscopic anatomy, ultrastructure and histophysiology of tissues and organs of mammals. (Haley)

ZOOL 608. ZOOLOGY SEMINAR (1-6)
Repeatable to a maximum of six credits.
Topics: a. cell biology; b. developmental biology; c. estuarine and marine biology; d. genetics and marine biology; d. genetics; e. parasitology; f. physiology; g. systematic and evolutionary biology; i. behavior; j. recent advances; k. endocrinology; l. ecology.

ZOOL 609. SPECIAL PROBLEMS IN ZOOLOGY (1-6)
Repeatable to a maximum of six credits. One seminar a week for each subject selected: a. cell biology; b. developmental biology; c. estuarine and marine biology; d. genetics; e. parasitology; f. physiology; g. systematic and evolutionary biology; i. behavior; j. recent advances; k. endocrinology; l. ecology.

ZOOL 610. CELLUAR PHYSIOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in animal or plant physiology, one year of organic chemistry, one year of physics, and a course in biochemistry. Recommended, ZOOL 411 or an equivalent course in cytology or cell biology. A study of the structure and functions of cells on the molecular, subcellular and cellular levels by investigations and discussions of their physical, chemical, and microscopic properties.

ZOOL 612. ELECTRON MICROSCOPY LABORATORY (3)
Two three-hour laboratories per week, arranged. Prerequisite, a lecture course in electron microscopy and permission of instructor. Preparation and study of biological materials by electron microscopy. Includes examination of standard tissue and an individual research project. (Goode)

ZOOL 615. BIOLOGICAL ULTRASTRUCTURE (3)
Three hours of lecture-discussion a week. Prerequisite, cell biology or histology, or permission of instructor. The ultrastructure of cells and tissues, with emphasis on interpretation and correlation of ultrastructure and function. (Goode)

ZOOL 616. ADVANCED TOPICS IN CELL BIOLOGY (3)
Three lecture-discussion periods a week. Prerequisites, one year of biochemistry, one year of physics, a course in cell biology or physiology, or permission of the instructor. An inquiry into the physico-chemical background and current advances in selected aspects of cell structure and function. (Brown)

ZOOL 621. COMPARATIVE PHYSIOLOGY (4)
Three lectures and one three-hour laboratory period each week. Prerequisite, one year of zoology, one year of organic chemistry, and one semester of physiology. The study of the differences and similarities in the functioning of organs of species of the animal kingdom.

ZOOL 624. EXPERIMENTAL MAMMALIAN PHYSIOLOGY (4)
Two four-hour laboratory periods a week. Prerequisites, a course in physiology and one year of chem-

istry above general chemistry. The theory, use and application to research of instrumentation normally in the physiology laboratory with an introduction to surgical techniques on both large and small animals. (Grollman)

ZOOL 625. COMPARATIVE INVERTEBRATE ENDOCRINOLOGY (3)
Three lecures a week. Prerequisites, one year of organic chemistry, a course in endocrinology and a course in physiology, or permission of instructor. A systematic approach to the structure and physiology of neuro-endocrine systems of invertebrates. (Linder)

ZOOL. 626. MOLECULAR NEUROBIOLOGY (3)
One three-hour lecture a week. Prerequisite, a course in physiology and a course in biochemistry. A biochemical and pharmacological approach to problems in physiology. A survery of neurochemistry and neuropharmacology; the study of action of hormones and drugs at the molecular and cellular level. (Contrera)

ZOOL 627. COMPARATIVE VERTEBRATE ENDOCRINOLOGY (3)
Three lectures each week. Prerequisite, one semester of biochemistry, physiology and endocrinology. Study of the difference and similarities in the structure and functioning of the endocrine organs of the vertebrate species. (Brinkley)

ZOOL 628. ELECTROPHYSIOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in physiology, one year of physics, and permission of the instructor. Concerned with electrical phenomena occurring in living matter and with the effect of electrical current on cells, with special emphasis on nerves and muscles. (Levitan)

ZOOL. 630. ORGANOGENESIS (4)
Two lectures and four hours of laboratory a week. Prerequisite, a course in embryology. The experimental basis of developmental mechanics. (Ramm)

ZOOL 640. POPULATION GENETICS (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, a course in genetics. The role of mutation, selection, migration, inbreeding, and stochastic process in evloution. (Highton)

ZOOL 641. ECOLOGICAL GENETICS (4)
Two lectures and six hours of laboratory a week. Prerequisites, a course in genetics and a course in ecology, or permission of the instructor. Analysis of the interactions between genotype and environment in natural and experimental populations of animals. (Potter)

ZOOL 642. DEVELOPMENTAL GENETICS (3)
Three lecture-discussion periods per week. Prerequisites, courses in molecular genetics and developmental or cell biology, or permission of the instructor. Differential gene function and its regulation in developing systems. Genes and the analysis of developmental processes. (Imberski)

ZOOL 643. CELLULAR GENETICS (3)
Two 1½ hour lecture-discussion periods a week. Prerequisites, one year of genetics including basic molecular genetics or permission of the instructor. The course will evaluate studies using protozoan systems as models for analyzing phenomena of nuclear differentiation, cytoplasmic heredity and control of cellular organization. (Barnett)

ZOOL 650. SYSTEMATIC ZOOLOGY (4)
Three lectures and one three-hour laboratory period a week. The principles and methods involved in the classification of animals, with emphasis on population dynamics and speciation. Methods of evaluating taxonomic data, principles of zoological nomenclature, field and museum techniques, and the factors influencing the distribution of animals are also stressed. (Highton)

ZOOL 660. COMPARATIVE BEHAVIOR (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, usually a course in behavior and one in physiology, and permission of the instructor. Orientation and migration, communication, coding, brain and behavior, biological rhythms, and hormones and behavior are the main subjects that will be considered. (Schleidt)

ZOOL 665. SOCIOBIOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in behavior and permission of the instructor. Deals with the description and analysis of animal social organizations, the adaptive nature of animal societies, the effects of early experience, and the role of communication in the integration of animal groups. (Eisenberg)

ZOOL 670. ANALYSIS OF ANIMAL POPULATIONS (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, a course in ecology or permission of instructor. An advanced course in animal ecology with a focus on populations. Studies of growth and regulation of animal populations are emphasized. (Morse)

ZOOL 671. QUANTITATIVE ZOOLOGY (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, MATH 140 or equivalent and permission of instructor. A consideration of the statistical techniques of principal importance in the analysis of biological data.

ZOOL 674. QUANTITATIVE FIELD ECOLOGY (4)
One full day per week. Prerequisites, animal or plant ecology, statistics, and permission of instructor. Group-oriented formulation of hypotheses, collection of data, analysis and discussion of results. Current problems in community and population ecology to be studied in the field. Extended field trips.

ZOOL 676. BEHAVIORAL ECOLOGY (4)
Prerequisites, a course in ecology and a course in behavior, or permission of the instructor. Two lecture-recitation periods and six hours of laboratory per week. The role of interactions among organisms and between organism and environment upon the dynamics and resource utilization of animals.

ZOOL 681. PHYSIOLOGICAL ECOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in invertebrate zoology, physiology and in ecology. An in-depth comparative study of the physiological interactions of

marine and estuarine invertebrates and their environment. (Pierce)

ZOOL 682. ECOLOGY OF MARINE INVERTEBRATES (4)
Two lectures and six hours of laboratory a week (including some Saturday field trips). Prerequisites, a course in animal ecology, or hydrobiology, and invertebrate zoology, or permission of instructor. The distribution, abundance, and adaptations of marine and estuarine invertebrates as related to the factors of those environments.

ZOOL 686. MARINE AND ESTUARINE PROTOZOA (4)
Two lectures and six hours of laboratory per week. An in-depth study of the taxonomic and morphological diversities, life histories, and autecologies of the protozoan fauna of marine and estuarine environments. Special emphasis will be placed on Chesapeake Bay forms. Field work will be an integral part of the laboratory, and shipboard experience is anticipated. Permission of instructor required. (Small)

ZOOL 708, 709. LECTURES IN ZOOLOGY (1-3) (1-3)
One, two or three lectures a week. Advanced lectures by outstanding authorities in their particular field of zoology. As the subject matter is continually changing, a student may register several times, receiving credit for several semesters.

ZOOL 770. EXPERIMENTAL PARASITOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in parasitology and permission of the instructor. Experiments performed utilizing living parasites in laboratory animals to illustrate various aspects of the host-parasite relationship. (Jachowski)

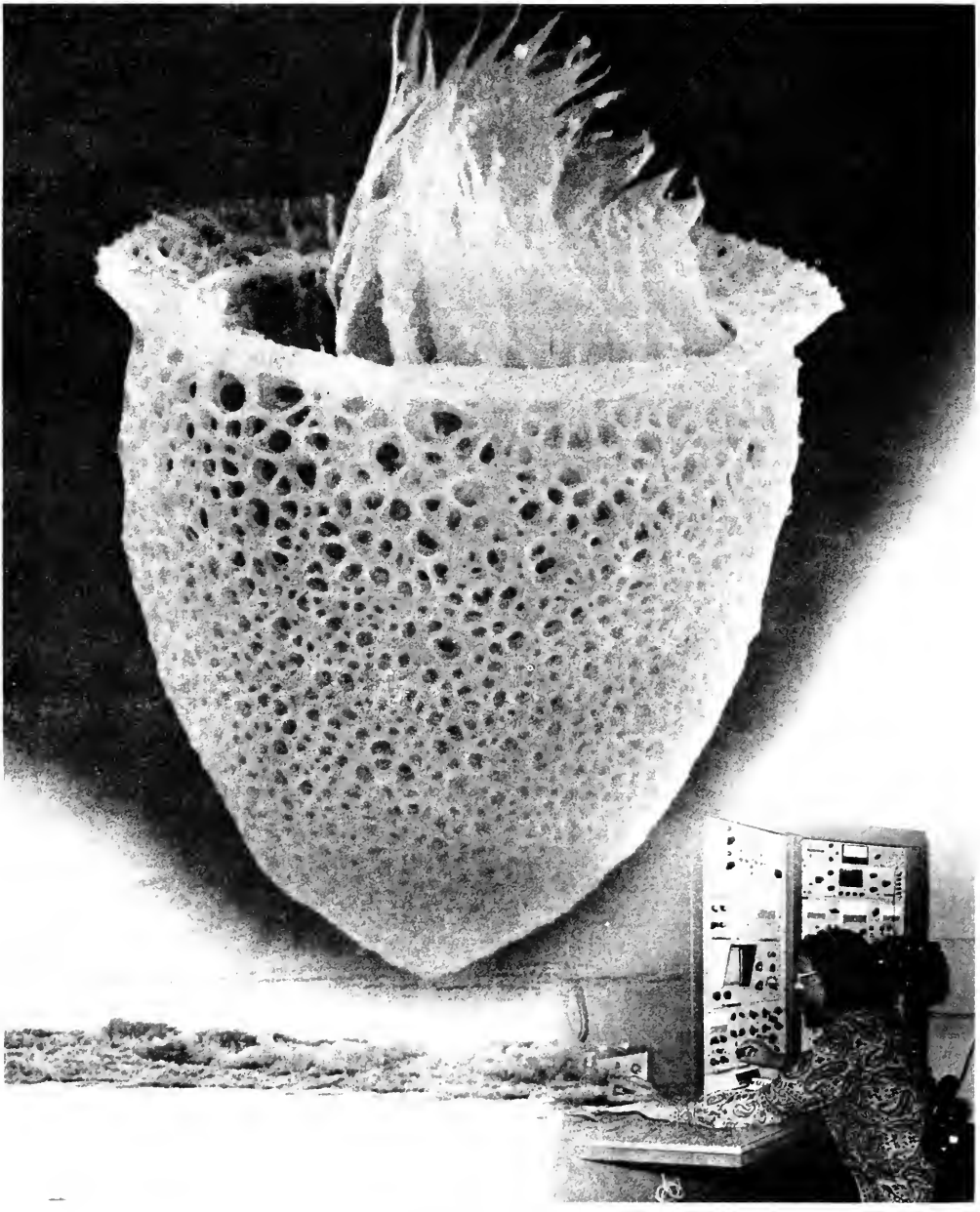
ZOOL 771. HELMINTHOLOGY (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, two years of zoology and permission of the instructor. A study of the classification, structure and biology of helminths.

ZOOL 778. ADVANCED TOPICS IN PROTOZOOLOGY (4)
The advanced study and analysis of selected protozoological topics; e.g., advanced cytology and techniques, morphogenesis, and systematics and evolution Two lectures and six hours of laboratory per week, emphasizing the research literature. Prerequisite, a course in general protozoology or permission of instructor. Offered in alternate years. May be taken more than one since topic coverage will change. May be repeated to a maximum of twelve semester hours. (Small)

ZOOL 799. MASTER'S THESIS RESEARCH (1-6)

ZOOL 878. ADVANCED TOPICS IN PARASITOLOGY (1-4)
Prerequisites, advanced graduate standing and permission of the instructor. The content of the course changes frequently and students may register for it several times. The course will consist of critical discussions of the published literature and current problems in parasitology. 1. host-parasite relationships, 2. ecology of parasites, 3. immunity to parasites, and 4. physiology of parasites.

ZOOL 899. DOCTORAL DISSERTATION RESEARCH (1-8)



SCANNING ELECTRON MICROGRAPH OF PETALOTRICHA SP. (1240 Diameters)
Department of Zoology

The Graduate Faculty

AARON, Henry J., Associate Professor of Economics
BA, University of California at Los Angeles, 1958; MA, Harvard University, 1960; PhD, 1963.

ABRAMS, Marshall D., Associate Professor of Electrical Engineering
BS, Carnegie-Mellon University, 1962; MS, University of Pittsburgh, 1963; PhD, 1966.

ADAMS, John Q., III, Associate Professor of Economics
AB, Oberlin College, 1960; PhD, University of Texas, 1965.

ADAMS, William W., Professor of Mathematics
BA, University of California at Los Angeles, 1959; PhD, Columbia University, 1964.

ADELMAN, Irma, Professor of Economics
BS, University of California, 1950; MA, 1951; PhD, 1955.

ADKINS, Arthur J., Associate Professor of Secondary Education
BS, Saint Cloud State College, 1942; MA, University of Minnesota, 1947; PhD, 1958.

AGRAWALA, A. K., Assistant Professor of Computer Science
PhD, Harvard University, 1970.

AGRE, Gene P., Associate Professor of Education
BA, Macalester College, 1951; BS, University of Minnesota, 1953; MA, 1956; PhD, University of Illinois, 1964.

A'HEARN, Michael F., Assistant Professor of Astronomy
BS, Boston College, 1961; PhD, University of Wisconsin, 1966.

AHNERT, Frank O., Professor of Geography
PhD, University of Heidelberg, 1953.

AHRENS, Richard A., Associate Professor of Food and Nutrition
BS, University of Wisconsin, 1958; PhD, University of California at Davis, 1963.

ALBERT, Thomas F., Associate Professor of Veterinary Science
BS, Pennsylvania State University, 1958; VMD, University of Pennsylvania, 1962; PhD, Georgetown University, 1972.

ALEXANDER, James C., Associate Professor of Mathematics and Statistics
BA, The Johns Hopkins University, 1964; PhD, 1968.

ALEXANDER, M. H., Assistant Professor, Institute for Molecular Physics
BA, Harvard College, 1964; PhD, University of Paris, 1967.

ALLAN, J. David, Assistant Professor of Zoology
BSc, University of British Columbia, 1966; MS, University of Michigan, 1968; PhD, 1971.

ALLEN, Redfield W., Professor of Mechanical Engineering
BS, University of Maryland, 1943; MS, 1949; PhD, University of Minnesota, 1959.

ALLEN, Thomas, Associate Professor of Counseling and Personnel Services
BS, Northwestern University, 1950; MA, University of Maryland, 1964; PhD, 1966.

ALLEY, Carroll O., Jr., Professor of Physics
BS, University of Richmond, 1948; MA, Princeton University, 1951; PhD, 1962.

ALMENAS, Kazys K., Associate Professor of Nuclear Engineering
BS, University of Nebraska, 1957; PhD, University and Polytechnic of Warsaw, 1968.

ALMON, Clopper, Jr., Professor of Economics
AB, Vanderbilt University, 1956; MA, Harvard University, 1961; PhD, 1962.

AMERSHEK, Kathleen G., Associate Professor of Early Childhood and Elementary Education
BS, State Teachers College, 1951; MEd, Pennsylvania State University, 1957; PhD, University of Minnesota, 1965.

AMMON, Herman L., Associate Professor of Chemistry
ScB, Brown University, 1958; PhD, University of Washington, 1962.

ANAND, Davinder K., Professor of Mechanical Engineering
BS, George Washington University, 1959; MS, 1961; DSc, 1965.

ANASTOS, George, Professor of Zoology
BS, University of Akron, 1942; MA, Harvard University, 1947; PhD, 1949.

ANDERSON, Charles R., Professor of Secondary Education and Assistant to the Dean
BS, University of Maryland, 1957; MEd, 1959; EdD, 1969.

ANDERSON, Frank G., Associate Professor of Anthropology
AB, Cornell University, 1941; PhD, University of New Mexico, 1951.

ANDERSON, Henry, Professor of Business Administration
BA, University of London, 1939; MBA, Columbia University, 1948; PhD, 1959.

ANDERSON, J. Paul, Professor of Education, Administration, Supervision, and Curriculum
BS, University of Minnesota, 1942; MA, 1948; PhD, 1960.

ANDERSON, J. Robert, Associate Professor of Physics
BS, State University of Iowa, 1956; PhD, 1963.

ANDERSON, John D., Jr., Lecturer in Aerospace Engineering
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BS, Central Connecticut State College, 1941; MS, Ohio State University, 1949; EdD, University of Maryland, 1952.

TIFFT, Margaret A., Associate Professor of Health Education
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BS, U.S. Naval Academy, 1957; MS, Stanford University, 1961; PhD, 1966.

TRAVER, Paul, Professor of Music
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DePaul University; Illinois Wesleyan University; PhD, University of Michigan, 1958.

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BS, University of Maryland, 1931; MS, 1934; PhD, 1936.

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BS, University of Pennsylvania, 1955; BS, 1956; MS, 1959; MS, University of Michigan, 1963; PhD, 1966.

VESENTINI, Edoardo, Professor of Mathematics
Laurea in scienzse matematiche, Universitá di Milano, 1950; Libera docenza in geometra, Universitá di Roma, 1956.

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AB, George Washington University, 1935; MA, 1936; PhD, 1947.

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MSc, Massachusetts Agriculture College, 1922; MS, Rutgers University, 1924; PhD, Columbia University, 1929.

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AB, College of William and Mary, 1951; MEd, Pennsylvania State University, 1956; DEd, 1962.

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WEIGANT, Leo A., Assistant Professor of English
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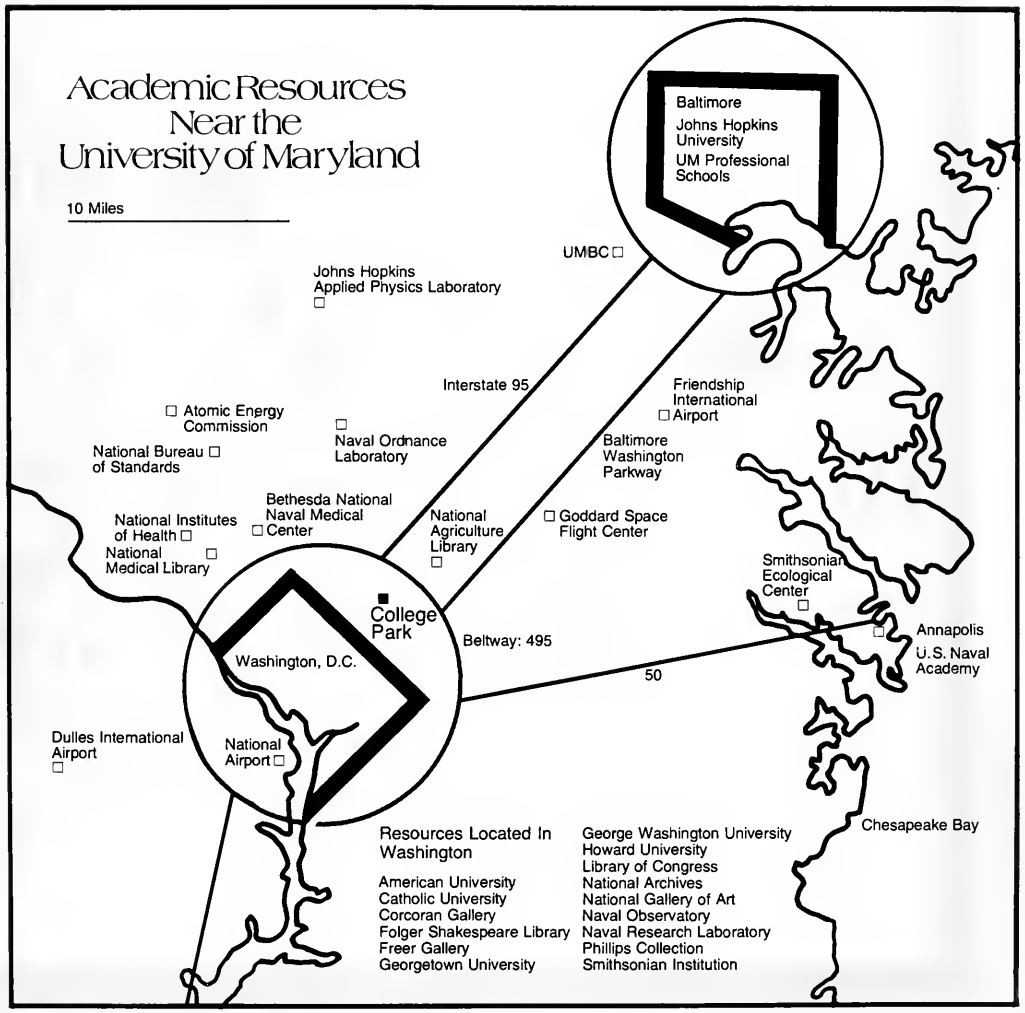
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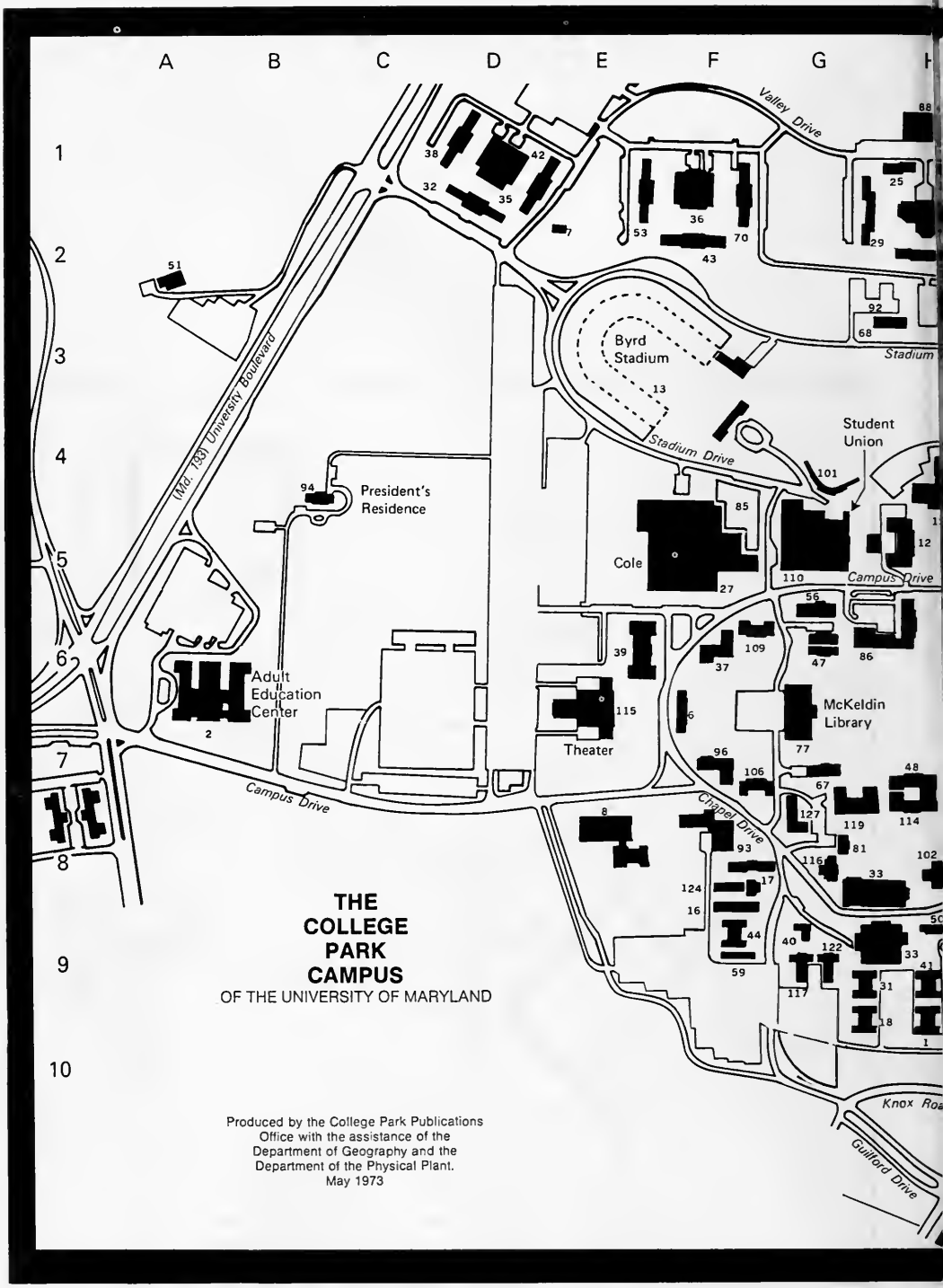
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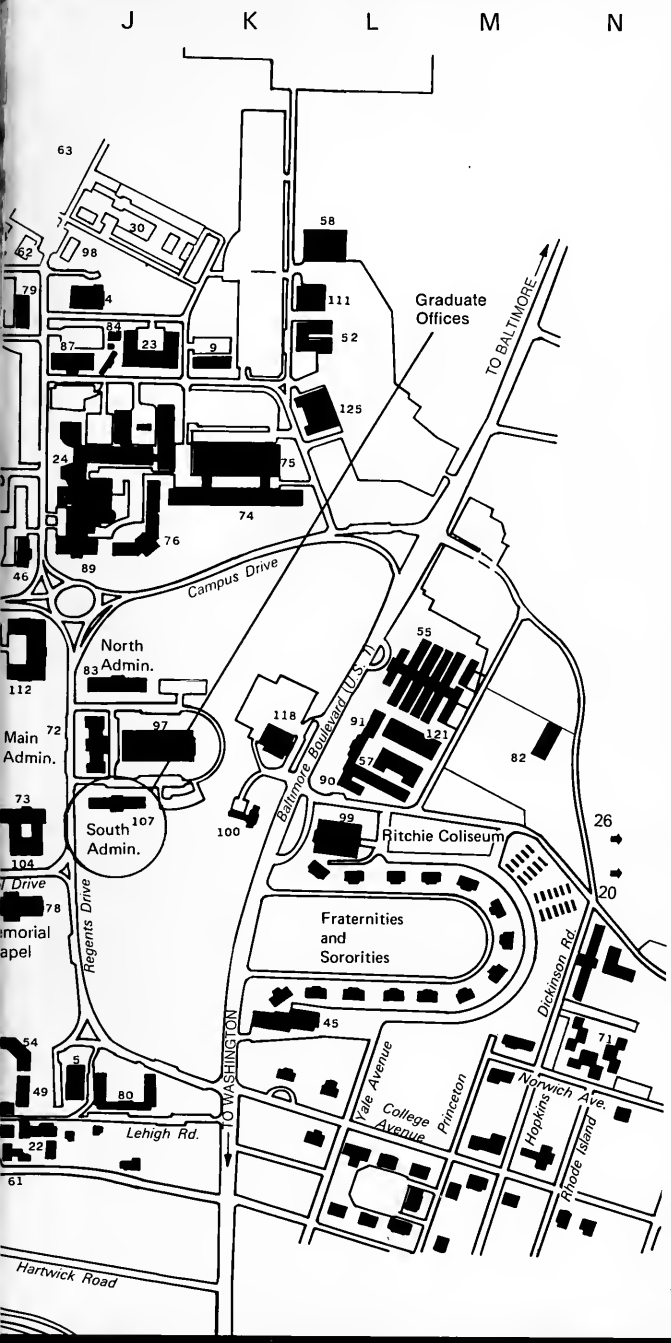

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