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University of Maryland College Park Campus

Graduate Catalog 1975-76

University of Maryland College Park Campus Graduate Catalog 1975-76

College Park
Publications Office

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College of Agriculture.
- Agricultural and Extension Education
- Agricultural and Resource Economics
- Agricultural Engineering
- Agronomy
- Animal Science
- Dairy Science
- Horticulture
- Institute of Applied Agriculture
- Poultry Science
- Veterinary Science

Other Units within the Division:
- Botany
- Chemistry
- Entomology
- Geology
- Microbiology
- Zoology

Division of Arts and Humanities:

School of Architecture

College of Journalism

Other Units within the Division:
- American Studies Program
- Art
- Classics
- Dance
- English
- French and Italian
- Germanic and Slavic
- History
- Music
- Oriental and Hebrew Program
- Philosophy
- Spanish and Portuguese
- Speech and Dramatic Art

Division of Behavioral and Social Sciences:

College of Business and Management

Other Units within the Division:
- Afro-American Studies
- Anthropology
- Bureau of Business and Economic Research
- Bureau of Governmental Research
- Economics
- Geography
- Government and Politics
- Hearing and Speech Sciences
- Information Systems Management
- Institute for Urban Studies
- Institute of Criminal Justice and Criminology
- Linguistics Program
- Psychology
- Sociology

Division of Human and Community Resources:

College of Education.
- Administration Supervision and Curriculum

Counseling and Personnel Services
- Early Childhood Elementary Education
- Industrial Education
- Institute for Child Study
- Measurement & Statistics
- Secondary Education
- Special Education

College of Human Ecology
- Family and Community Development
- Foods, Nutrition and Institution Administration
- Housing and Applied Design
- Textiles and Consumer Economics

College of Library and Information Services

College of Physical Education, Recreation and Health.
- Health Education
- Physical Education
- Recreation

Division of Mathematical and Physical Sciences and Engineering:

College of Engineering
- Aero-Space Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Fire Protection Curriculum
- Mechanical Engineering

Other Units within the Division.
- Applied Mathematics Program
- Center for Materials Research
- Computer Science
- Institute for Fluid Dynamics & Applied Mathematics
- Meteorology Program
- Institute for Molecular Physics
- Mathematics
- Physics and Astronomy

Academic Calendar

Fall Semester 1975

August 25, 26
Monday, Tuesday
Registration for Fall Semester

August 27
Wednesday
First day of instruction

September 1
Monday
Labor Day Holiday

September 2-10
Tuesday-Wednesday
Late Registration

September 16
Tuesday
Last day to submit applications for December 1975 diplomas

October 18
Friday
Master's approved program forms due in the Graduate School office for December master's graduates

November 21
Friday
Final date for submission of forms certifying completion of master's theses and doctoral dissertations in the Graduate School office

November 26-28
Wednesday-Friday
Thanksgiving Holiday recess

December 10
Wednesday
Last day of instruction

December 11
Thursday
Grades due in Registrations Office for graduating students
Exam study day

December 21
Sunday
Commencement, 2:00 p.m.

Spring Semester 1976

January 12, 13
Monday, Tuesday
Registration for Spring Semester

January 14
Wednesday
First day of instruction

February 3
Tuesday
Last day to submit applications for May 1976 diplomas

March 5
Friday
Master's approved program forms due in the Graduate School office for May master's graduates

March 6-March 14
Saturday, Sunday
Spring Recess

April 15
Thursday
Final date for submission of forms certifying completion of master's theses and doctoral dissertations in the Graduate School office

April 30
Friday
Oral examination reports, theses and dissertations, forms certifying non-thesis option due in the Graduate School office

May 5
Wednesday
Last day of instruction

May 6
Thursday
Grades due in Registrations Office for graduating students
Exam study day

May 7-May 14
Friday-Friday
Spring Semester examination period

May 15
Saturday
Commencement, 10:00 a.m.

University Officers
Board of Regents

Chairman
B. Herbert Brown

Vice Chairman
Hugh A. McMullen, Esq.

Secretary
Dr. Samuel H. Hoover, D.D.S.

Treasurer
L. Mercer Smith

Assistant Secretary
William G. Connelly

Assistant Treasurer
N. Thomas Whittington, Jr.

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The Honorable Young D. Hance, *ex officio*
Edward V. Hurley
Dr. Louis L. Kaplan
Peter F. O'Malley, Esq.
Miss Judith Sachwald
John C. Scarbath
Joseph D. Tydings, Esq.
(one vacancy)

Central Administration of the University

President
Wilson H. Elkins

Vice President for General Administration
Donald W. O'Connell

Vice President for Academic Affairs
R. Lee Hornbake

Vice President for Graduate Studies and Research
Michael J. Pelczar, Jr.

Vice President for Agricultural Affairs and Legislative Relations
Frank L. Bentz, Jr.

College Park Campus Administration

Chancellor
Robert L. Gluckstern

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, Jr.

Provosts at College Park

Division of Agricultural and Life Sciences
Francis C. Stark

Division of Arts and Humanities
Robert A. Corrigan

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

School of Architecture
John W. Hill

College of Agriculture
Gordon M. Cairns

College of Business and Management
Rudolph P. Lamone

College of Education
Robert L. Emans

College of Engineering
Robert B. Beckmann

College of Human Ecology
John R. Beaton

College of Journalism
Ray E. Hiebert

College of Library and Information Services
Acting Dean: Henry J. Dubester

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

Administrative Dean for Graduate Studies
David S. Sparks

Administrative Dean for Summer Programs
Melvin N. Bernstein

Administrative Dean for Undergraduate Studies
Robert E. Shoenberg

Administrative Dean of Academic Services and Facilities
Vacant

Graduate School 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

Robert E. Menzer, B.S., University of Pennsylvania, 1960; M.S., University of Maryland, 1962; Ph.D., University of Wisconsin, 1964

Assistant Dean for Graduate Studies

David A. Goldberg, B.Eng.Phys., Cornell University, 1958; M.S., 1960; Ph.D., Johns Hopkins University, 1967.

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 Director

Lois M. Lyon, B.A., University of Michigan, 1952.

Graduate Council

Ex-officio Councillors

Chancellor, Robert L. Gluckstern
Vice Chancellor, George H. Callcott
Dean, David S. Sparks
Associate Dean, Robert E. Menzer

Appointed Councillors

Prof. John Corliss, Zoology
Prof. Clifford Sayre, Mechanical Engineering
Prof. Peter P. Lejins, Institute for Criminal Justice and Criminology
Prof. Marie Davidson, Institute for Child Study

Elected Councillors

Prof. Allen Steinhauer, Entomology
Prof. Mark Keeney, Biochemistry
Prof. Francis Stark, Horticulture
Ms. Jenette M. Esser, Zoology
Prof. Manoj Banerjee, Physics
Prof. Andrew DeRocco, Molecular Physics
Prof. Paul J. Smith, Mathematics
Mr. Terence A. Murphy
Prof. Walter Deshler, Geography
Prof. Howard Wright, College of Business and Management
Prof. Edward Dager, Sociology
Ms. Maureen McCall, Psychology
Prof. Beatrice Fink, French and Italian
Prof. Carl Bode, English
Prof. Roger Meersman, Speech and Dramatic Art
Mr. Ken Baskin, English
Prof. David Williams, Early Childhood—Elementary Education
Prof. Betty Smith, Textiles and Consumer Economics
Prof. George Marx, Counseling and Personnel Services
Mr. Gregory Nenstiel, Social Foundations of Education

Committees of the Graduate Council

Committee on Academic Standards

Prof. Edward P. Karlander, Chairman
Botany
Mr. Ken Baskin, English
Prof. Hans Dachler, Psychology
Prof. Howard J. DeVoe, Chemistry
Prof. Beatrice Fink, French
Prof. James B. Lynch, Art
Prof. Ralph D. Myers, Physics
Mr. Gregory Nenstiel, Social Foundations of Education
Prof. Mancur Olson, Economics
Prof. William D. Schafer, Measurement and Statistics
Prof. Francis Stark, Horticulture
Prof. Leonard Taylor, Electrical Engineering
Dean Henry H. Walbesser, Mathematics—Education
Dean Robert E. Menzer, *ex officio*

Committee on Admissions

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Agric. and Resource Economics
Ms. Kathleen Alligood, Mathematics
Dean Margaret Chisholm, Library Science
Prof. Burris Husman, Physical Education
Prof. Richard Jaquith, Chemistry
Mr. Gerald Lordan, Early Childhood—Elementary Education
Prof. Morris McClure, Administration, Supervision and Curriculum
Prof. Irwin Goldstein, Psychology
Prof. James Miller, Agronomy
Prof. W.E. Schlaretzki, Philosophy
Prof. Elske Smith, Astronomy
Prof. Paul Smith, Mathematics
Mr. Carl L. Seidel, *ex officio*

Committee on Elections

Prof. Roger Meersman, Chairman
Speech and Drama
Prof. Kenneth Fulton, Agricultural Engineering
Prof. Janet G. Hunt, Sociology
Prof. David G. Kyle, Institute for Child Study
Prof. Leda Wilson, Family and Community Development
Ms. Alice M. Piper, *ex officio*

Committee on Fellowships

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Institute for Molecular Physics
Prof. Stephen G. Brush, History and IFDAM
Prof. Marilyn Church, Elementary Education
Mr. Dewey Covington, Government and Politics
Prof. Edward Z. Dager, Sociology
Prof. Albert Gomezplata, Chemical Engineering
Prof. Lawrence Krisher, Molecular Physics
Prof. David C. Lay, Mathematics
Mr. Hugh Mose, Civil Engineering
Prof. Philip Rovner, Spanish and Portuguese
Prof. Joseph Soares, Poultry
Prof. Dalmas Taylor, Psychology
Dean David Goldberg, *ex officio*

Committee on Program Review

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Administration, Supervision and Curriculum
Prof. Nancy Anderson, Psychology
Prof. Robert Bennett, Economics
Prof. Sidney Ishee, Agricultural Economics
Prof. Jacob Goldhaber, Mathematics
Prof. Donald C. Gordon, History
Prof. Wesley L. Harris, Agricultural Engineering
Prof. Robert Munn, Chemistry
Mr. Michael Padbury, Business and Management
Prof. Clifford Sayre, Mechanical Engineering
Prof. Betty Smith, Textiles and Consumer Economics
Ms. Nancy Strunah, Physical Education
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Committee on Graduate Faculty

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Prof. James Anderson, Physics
Prof. William Bickley, Entomology
Ms. Burdelle Boyd, Spanish and Portuguese
Prof. Gertrude Fish, Housing and Applied Design
Prof. James Grunig, Journalism
Prof. Chester Holmlund, Chemistry
Prof. Anne Ingram, Physical Education
Prof. William MacBain, French and Italian
Prof. James Miller, Agronomy
Prof. Hayes Newby, Hearing and Speech Science
Prof. David Rodenhuis, Meteorology
Ms. Barbara Baker, Music
Prof. Gladys Wiggin, Education
Dean Robert E. Menzer, *ex officio*

Committee on Programs and Courses

Prof. Rachel Dardis, Chairwoman
Textiles and Consumer Economics
Prof. Richard Austing, Computer Science Center
Prof. Howard Brinkley, Zoology
Sr. Elena Colicelli, Chemistry
Prof. Robert Harper, Geography
Prof. James W. Longest, Agricultural and Extension Education
Prof. John Kurtz, Institute for Child Study
Prof. George Marx, Counseling and Personnel Services
Prof. Charles Murphy, English
Mr. Eugene Owen, Agricultural and Extension Education
Prof. Elizabeth Pemberton, Art

Prof. Robert Ragan, Civil Engineering
Prof. George Snow, Physics
Prof. Robert Stephens, Administration Supervision and Curriculum
Dean Robert E. Menzer, *ex officio*

Committee on Publications

Prof. Donald Maley, Chairman Industrial Education
Prof. Allen Bandel, Agronomy
Prof. John Brown, Philosophy
Mr. Gerald Day, Industrial Education
Ms. Halaine Gary, Library Sciences
Prof. Frank Hetrick, Microbiology
Prof. George Levitine, Art
Prof. Marjorie Perloff, English
Ms. Alice M. Piper, *ex officio*

Committee on Research

Prof. John Corliss, chairman Zoology
Prof. Richard Ahrens, Food, Nutrition, and Institution Administration
Prof. Roger Bell, Astronomy
Prof. Leonard Bull, Dairy Science
Prof. James Dally, Mechanical Engineering
Prof. Dudley Dillard, Economics
Prof. Regina Goff, Elementary Education
Prof. Wilhelmina Jashemski, History
Prof. Peter Lejins, Institute of Criminal Justice and Criminology
Ms. Maureen McCall, Psychology
Prof. Henry Mendeloff, Spanish and Portuguese
Prof. Martin Reiser, Electrical Engineering
Prof. Bruce Rogers, Measurement and Statistics
Prof. Robert Steinman, Psychology
Mr. Russell Tobias, Physics
Prof. Richard Vitzthum, English
Dean Robert E. Menzer, *ex officio*

Committee on Student Life

Prof. John M. Curtis, Chairman Agricultural Economics
Prof. Carl Bode, English
Prof. Robert R. Dies, Psychology
Ms. Jennette Esser, Zoology
Prof. Mark Hardwick, Counseling and Personnel Services
Prof. Agnes Hatfield, Institute for Child Study
Prof. Richard Highton, Zoology
Prof. Robert Hirzel, Sociology
Prof. Henry Lepper, Civil Engineering
Prof. Stephen Loeb, Business and Management
Prof. Charles L. Mulchi, Agronomy
Mr. Terence Murphy, Molecular Physics
Dean David A. Goldberg, *ex officio*

University of Maryland Campuses—

Information concerning graduate programs offered on University of Maryland campuses other than College Park may be obtained by writing directly to or calling the appropriate officers for graduate study.

Baltimore City

Programs available:

School of Dentistry:
- Anatomy
- Biochemistry
- Histology and Embryology
- Microbiology
- Oral Pathology
- Oral Surgery
- Physiology

School of Medicine:
- Anatomy
- Biological Chemistry
- Biophysics
- Cell Biology and Pharmacology
- Legal Medicine
- Microbiology
- Pathology
- Physiology

School of Nursing

School of Pharmacy:
- Medicinal Chemistry
- Pharmacology and Toxicology
- Pharmacy—Pharmaceutics and Institutional Pharmacy
- Pharmacognosy

School of Social Work and Community Planning

Contact:

Dr. William J. Kinnard, Jr., Acting Dean
for Graduate Studies and Research
University of Maryland, Baltimore City
Baltimore, Maryland 21201
(301) 528-7131

Baltimore County

Programs offered:

Applied Mathematics
Biological and Medicinal Chemistry
Community-Clinical Psychology
Experimental Biology-Health Sciences
Policy Sciences

Contact:

Dr. Joseph F. Mulligan, Director
of Graduate Studies and Research
University of Maryland, Baltimore County
Catonsville, Maryland 21228
(301) 455-2538

Eastern Shore

Currently, there are no graduate level courses offered at the Eastern Shore campus.

Contact:

Dr. Joseph Wutoh, Vice Chancellor
for Academic Affairs
University of Maryland, Eastern Shore
Princess Anne, Maryland 21853
(301) 651-2200

University College

Although University College, the adult education evening division of the University of Maryland, is primarily an undergraduate college, there are some courses offered through this division which are eligible for graduate credit.

Contact:

Dr. Mason G. Daly, Dean
University College
Center for Adult Education
University of Maryland
College Park, Maryland 20742
(301) 454-5756

General Information

Introduction

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 on this campus." That Constitution, as amended in 1968 and 1974, 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 its Committees, and the 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 more than sixty-five graduate departments and programs leading to degrees awarded by the Graduate Faculty on the College Park Campus. The faculties of the individual academic departments and interdisciplinary graduate programs may establish additional requirements for admission or for degrees above the minima established by the Graduate Council.

The Assembly of the Graduate Faculty consists of all full and associate members of the Graduate Faculty who through their participation in research and graduate instruction have displayed 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 ten standing committees. Included are committees on: Academic Standards, Admissions, Elections, Fellowships, Program Review, Graduate Faculty, Programs and Courses, Publications, Research, and Student Life. Membership on these committees is limited to members of the Graduate Faculty and graduate students. Members are appointed by the Dean for Graduate Studies for terms of three years.

Enrollment

In the fall of 1974 there were slightly more than 7,500 graduate students enrolled on the College Park Campus. Of that number approximately 3,000 were full-time students. Fifty-six percent of the total were enrolled in master's degree programs, and forty percent had been admitted to doctoral programs. The average age of the student body was nearly 29 years of age.

During 1974-75 the Graduate Faculty recommended the awarding of 385 doctoral degrees and 1,416 master's degrees.

Location

Located on 1,300 acres in Prince Georges County, eight miles from the National Capital 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 contain approximately 1,800,000 volumes, and they subscribe to more than 14,000 pe. ,dicals and newspapers. Additional collections of research materials are available on microfilm, microfiche, phonorecords, tapes, and films.

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 Beltsville Agricultural Research Center of the United States Department of Agriculture has stimulated the development of both laboratories and opportunities for field research in the agricultural and life 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 the University of Maryland Center for Environmental and Estuarine Studies with research facilities at Horn Point near Cambridge, Crisfield and at Solomons Island, Maryland.

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 160 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 one of the world's largest and most sophisticated long-wavelength radio telescopes located in Clark Lake, California and a cosmic ray laboratory located in New Mexico.

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 Hirshorn Museum, 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 Kennedy Center for the Performing Arts and the Filene Center (Wolf Trap Farm Park) have 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 local point for a vigorous and expanding national research effort in the atmospheric sciences. NCAR is operated under the sponsorship of the National Science Foundation 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 52 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 highest energy machine.

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[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Aerospace Engineering	M.S., Ph.D.
Agricultural Engineering	M.S., Ph.D.
Agricultural and Extension Education[2]	M.S., A.G.S., Ph.D.
Agricultural and Resource Economics	M.S., Ph.D.
Agronomy	M.S., Ph.D.
American Studies[3]	M.A., Ph.D.
Animal Science	M.S., Ph.D.
Applied Mathematics	M.A., Ph.D.
Art	M.A., M.F.A., Ph.D.
Astronomy[4]	M.S., Ph.D.
Botany	M.S., Ph.D.
Business Administration[1]	M.B.A., D.B.A.
Chemical Engineering	M.S., Ph.D.
Chemistry	M.S., Ph.D.
Civil Engineering	M.S., Ph.D.
Comparative Literature	M.A., Ph.D.
Computer Science[4]	M.S., Ph.D.
Counseling and Personnel Services[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Criminal Justice and Criminology[4]	M.A., Ph.D.
Dairy Science	M.S., Ph.D.
Early Childhood-Elementary Education[3]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Economics[4]	M.A., Ph.D.
Electrical Engineering	M.S., Ph.D.
Engineering Materials	M.S., Ph.D.
English Language and Literature	M.A., Ph.D.
Entomology	M.S., Ph.D.
Family and Community Development[4]	M.S.
Food, Nutrition and Institutional Administration[4]	M.S.
Food Science	M.S., Ph.D.
Foundations of Education[3]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
French Language and Literature[6]	M.A., Ph.D.
Geography[6]	M.A., Ph.D.
Germanic Language and Literature	M.A., Ph.D.
Government and Politics[6]	M.A., Ph.D.
Hearing and Speech Sciences[4]	M.A., Ph.D.
Health Education	M.A., Ed.D., Ph.D.
History[4]	M.A., Ph.D.
Horticulture	M.S., Ph.D.
Human Development Education[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Industrial Education[3]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Journalism[4]	M.A.
Library and Information Services[4]	M.L.S., Ph.D
Mathematics	M.A., Ph.D.
Measurement and Statistics[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Mechanical Engineering[6]	M.S., Ph.D.
Meteorology	M.S., Ph.D.
Microbiology[5]	M.S., Ph.D.
Nuclear Engineering	M.S., Ph.D.
Music[6]	M.M., D.M.A., Ph.D.
Nutritional Sciences	M.S., Ph.D.
Philosophy[4]	M.A., Ph.D.
Physical Education	M.A., Ed.D., Ph.D.
Physics[5]	M.S., Ph.D.
Poultry Science	M.S., Ph.D.
Psychology[6]	M.A., M.S., Ph.D.
Recreation[4]	M.A., Ed.D., Ph.D.
Secondary Education[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Sociology[6]	M.A., Ph.D.
Spanish and Portuguese Languages and Literature	M.A., Ph.D.
Special Education[2]	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Speech and Dramatic Art[4]	M.A.
Textiles and Consumer Economics[4]	M.S.
Urban Studies[6]	M.A.
Zoology	M.S., Ph.D.

[1] ATGSB required (Advanced Test for Graduate Studies in Business)

[2] Miller Analogies Test required for admission

[3] Miller Analogies Test required only at doctoral level

[4] Graduate Record Examination Aptitude Test required.

[5] Graduate Record Examination Advanced Test required

[6] Both Aptitude and Advanced Graduate Record Examinations required

For further details on entrance examinations see Admission to Graduate School below.

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 departmental graduate admissions committees. In the case of foreign student applicants, the University's Director of International Education Services is also consulted. Standards for admission to doctoral programs are frequently higher than those for admission to master's programs.

In some programs applications for admission to graduate study by qualified students 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 other available resources.

There are, moreover, standards which apply to all applicants regardless of program. 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 identify those individuals who have a reasonable expectation of successfully completing a graduate program.

The decision on admission of an applicant is based primarily on some of the following critieria, depending on the specific program or department:

1. *Quality of previous undergraduate and graduate work.* As a matter of general policy within the Graduate School at College Park, the minimum standard as to quality of undergraduate work is a B average, or 3.0 on a 4.0 scale, in a program of study resulting in the award of a baccalaureate degree from a regionally accredited college or university. In addition, the student's undergraduate program should include completion of the prerequisites for graduate study in his or her chosen field. In individual programs, where resources are available, a few applicants who do not meet this minimum standard as to work done at the undergraduate level may be provisionally admitted if there is compelling evidence on the basis of other criteria of a reasonable likelihood of success in the program the person desires to enter. In the case of an applicant who has done some graduate work elsewhere, less weight may be, but is not necessarily, placed on the quality of the undergraduate academic record.

2. *Strength of letters of recommendation from persons competent to judge the applicant's probable success in graduate school.* Usually these letters are from the applicant's former professors who are able to give an in-depth evaluation of the applicant's strengths and weaknesses with respect to academic work. Additional recommendations may come from employers or supervisors who are familiar with the applicant's work experience. Applicants should instruct their references to send all letters of recommendation directly to the program in which they desire entrance. Some departments do not require letters of recommendation. (See application form.)

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

3 *Scores on a nationally standardized examination such as the Graduate Record Examinations, Admissions Test for Graduate Study in Business, Miller Analogies Test, and similar tests.* For additional information about standardized tests see instructions accompanying application forms. Because the predictive utility of these scores may vary from one group of applicants to another, a discriminating use of all relevant materials will be made in each applicant's case.

GRADUATE RECORD EXAMINATIONS (GRE)

Although many graduate programs do not require the GRE, almost all 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 ANALOGIES TEST (MAT)

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

4. *Statement by the applicant of his academic and career objectives and how these are related to the program of study proposed at this university.* It is important that the department or program of proposed study identify students whose objectives are consonant with the objectives of the program.

In addition to the above criteria, special consideration will be given to:

(1) *Residence of the applicant.* While the university desires to maintain a geographically diverse graduate student population, it also recognizes its responsibility to legal residents of the state. Every effort will be made to accommodate qualified Maryland residents.

(2) *Sex and minority group membership.* The University of Maryland, its Graduate School and each of its academic components have strong affirmative action programs for increasing the participation of minority groups (Black Americans, American Indians, Oriental Americans, Spanish-Americans) and women among its students, staff and faculty.

Financial Aid

Many departments are able to provide financial assistance in the form of teaching or research assistantships and fellowships to graduate student 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 are enrolled in either a Ph D or Ed D. program, and who agree to teach in a public institution of higher learning in the State of Maryland for a period of three years following receipt of their doctoral degree if a suitable position is offered The stipend is $2500 for the academic year with remission of tuition Although renewable annually, these fellowships normally carry a three year non-renewable tenure. Applications for this Program may be obtained from the Fellowship Office of the Graduate School.

The Graduate School Fellowships are awarded annually on a competitive basis. The stipend is $1,000 for the academic year, with remission of tuition. The standard application for financial aid will serve as an application for this Fellowship Program.

The primary basis on which fellowships are awarded is academic merit and promise. Financial need may be taken into consideration in deciding among comparably qualified students.

A fellowship is traditionally regarded as an award bestowed on a promising scholar which will provide him or her with sufficient income that he or she may be able to devote himself or herself essentially full time to scholarly pursuits. Hence it is generally expected that fellowship holders will not hold outside employment Exceptions to this policy can be authorize d by the Dean for Graduate Studies in cases of special need.

ASSISTANTSHIPS

Graduate Teaching Assistantships are also available to qualified graduate students. In addition to remission of tuition, these carry ten-month stipends ranging from $3,100 to $4,400. In certain departments, Graduate Research Assistantships, with roughly comparable stipends, are available on a ten or twelve month basis. Applications for assistantships should be made directly to the Department in which the applicant will study.

A few Resident Graduate Assistantships in the undergraduate residence halls are available. The stipend is $3,100 per year, plus remission of tuition, in exchange for half-time work as Residence Halls Staff members. These Resident Assistantships are open to both men and women. Applications for a Resident Graduate Assistantship should be made to the Director of Resident Life, University of Maryland, College Park, Maryland 20742.

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

STUDENT LOANS

National Direct Student Loan Funds are available to graduate students of the University of Maryland. The student may request up to $2,500 per year. Loans average $1,500 per year. Applications should be directed to the Director ,Office of Student Aid, North Administration Building, University of Maryland, College Park, Maryland 20742.

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-degree 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 Visiting Graduate Student who is in good standing as a graduate student at another institution (See also Visiting Graduate 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.

"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., Visiting Graduate 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 or she must submit a new application and fee 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 and financial aid 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 must apply *at least seven months* prior to the semester in which the student plans to begin his or her 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 department. 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 or her 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.

VISITING GRADUATE 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 or she 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 or she must apply for admission to the Graduate School of the University of Maryland, and pay the application fee. In lieu of transcripts, he or she must have his graduate dean certify, in writing, to the Graduate School that he or she is in good standing and that the credits will be accepted toward his or her 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 or she 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 or she contemplates study at the University of Maryland. When the applicant is ready to begin his or her studies, he or she 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. Approximately $525.00 a month, or $6300.00 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 or her financial obligations from his or her 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, 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 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, 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 or her official credentials to keep in his or her 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 and then destroyed.

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 or she 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 or her first registration. Identification as a graduate student, to be used thereafter, will be issued at the time of first registration.

Graduate Credit for Senior Undergraduates

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 the undergraduate dean, the provost of his or her division, the department or program offering the course, and the Graduate School, register for graduate courses, which may later be counted for graduate credit toward an advanced degree at the university if he or she 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 the procedure.

Undergraduate Credit For Graduate Level Courses

Subject to requirements determined by the graduate faculty members of the department or program offering the course, undergraduate students may register for graduate level courses, i.e., those numbered from 600 through 898 with the exception of 799, for undergraduate credit.

A student seeking to utilize this option will normally have earned an accumulated grade point average of 3.0, be in his or her senior year, have successfully completed, with a

grade of B or better, the prerequisite and correlative courses, and be a major in the appropriate or a closely related department. The student will be required to obtain prior approval of the department offering the course.

Enrollment in a graduate level course does not in any way imply subsequent departmental or Graduate School approval for admission into a graduate program, nor may the course be used as credit for a graduate degree at the University of Maryland.

Advising and Registration

Progress in an approved graduate degree program is a shared responsibility of the student and his or her faculty advisor. The student is responsible for compliance with the rules and procedures of the Graduate School and all applicable department or graduate program requirements which govern the individual program of study. In fulfilling this responsibility the student should seek the advice of his or her faculty advisor and the administrative officer of the department or program in which he or she is studying, as well as that of the staff of the Graduate School.

Registration for the newly admitted graduate student begins with a visit to the student's academic advisor in the graduate department or program to which the student has been admitted. There the student will obtain information about specific degree requirements which supplement those of the Graduate School and will develop, in consultation with a graduate faculty advisor, an individual program of study and research. (See statement of student responsibility.)

In developing that program the student will need to consult the *Schedule of Classes*, published just prior to each registration period by the Office of Registration, to obtain information about the times and places classes will be offered, the names of the professors or instructors who will be teaching a particular course or section, procedures for the payment of tuition and fees, dropping or adding a course, or making other changes in registration. It also contains the names, telephone numbers and office locations of persons who can supply additional information.

While most questions normally raised by graduate students, and most problems they meet, will be answered or resolved by the faculty advisor or a departmental committee, the student should remember that he or she is a student in the Graduate School, and its staff is specifically charged with the responsibility for assisting graduate students who need additional information, guidance or assistance. Further, the Dean for Graduate Studies is the individual to whom requests or petitions for exceptions or waivers of regulations or graduate degree requirements should be addressed and to whom appeals from decisions of departmental or program faculty or administrators should be directed.

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.

Designation of Full and Part-Time Graduate Students

In order to accurately reflect the involvement of graduate students in their programs of study and research and the use of university resources in those programs, the Graduate Council uses the graduate unit in making calculations to determine full or part-time student status in the administration of the minimum registration requirements described below and in responding to student requests for certification of full-time student status. The number of graduate units per semester credit hour is calculated in the following manner:

Courses in the series: 000-399 carry 2 units/credit hour

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

Courses in the series: 500-599 carry 5 units/credit hour.

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

Research course: 799 carries 12 units/credit hour.

Research course: 899 carries 18 units/credit hour.

To be certified as a full-time student a graduate student must be officially registered for a combination of courses equivalent to 48 units per semester. A graduate assistant holding a regular appointment is a full-time student if registered for 24 units in addition to the service appointment.

Minimum Registration Requirements

All graduate students making any demand upon the academic or support services of the university, whether taking courses, using university libraries, laboratories, computer facilities, office space, housing, or consulting with faculty advisors, taking comprehensive or final oral examinations, must register for the number of graduate units which will, in the judgment of the faculty advisor, accurately reflect the student's involvement in graduate study and use of university resources. In no case will registration be for less than 4 units.

Minimum Registration Requirements for Doctoral Candidates

Doctoral students who have been advanced to candidacy must register each semester, excluding summer sessions, until the degree is awarded. Those who have not completed the required 12 semester credit hours of Dissertation Research (899), or its equivalent, must register for a minimum of 18 graduate units each semester. Doctoral candidates whose demands upon the university are greater than that represented by this minimum registration will, of course, be expected to register for the number of units which will reflect their use of university resources.

Doctoral candidates who have completed the required minimum of 12 credit hours of Dissertation Research (899), or its equivalent, and who are making *no use* of university resources, must meet a Continuous Registration requirement in each semester, except for summer sessions, until the degree is awarded. This requirement is met by paying the $10 Continuous Registration fee. The fee may be paid in person or by mail directly to the Graduate School. It must be paid 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 or her doctoral program and admitted status to the Graduate School will be terminated. A new application for admission, with the consequent re-evaluation of the student's performance, will be required of a student wishing to resume a graduate program terminated under this regulation.

Grades for Graduate Students

The following grades are used in the evaluation of graduate student performance at the University of Maryland, College Park:

The conventional A through F grading system is used in graduate level courses. The A is calculated at 4 quality points, the B at 3 quality points, the C at 2 quality points, and the grades of D, F, and I receive no quality points. A student may repeat any course in an effort to earn a better grade. The later grade,

whether higher or lower, will be used in computing the grade point average. A minimum grade point average of 3.0 is required for graduation with a graduate degree. All courses taken after matriculation as a graduate student numbered 400 and above, except those numbered 799 or 899 and those graded with an S will be used in the calculation of the grade point average. No course taken after August 23, 1974, will be marked "not applicable" for the purpose of computing the grade point average of a graduate student. No graduate credit transferred from another institution will be included in the calculation of the grade point average.

A "Satisfactory or Failure" (S-F) grading system may be used, at the discretion of the department or program, for certain types of graduate study. These include courses which require independent field work, special projects, or Independent Study. Departmental seminars, workshops, and departmental courses in instructional methods may also be appropriate for the S-F grading system.

The "Pass-Fail" grade option, which may be elected by undergraduate students, is not available to students at the graduate level.

Thesis and dissertation research, and courses labelled "Independent Study" or "Special Problems" may use either the A-F or the S-F grading system. However, only one grading system will be used for a single course in a particular semester. The grading system will be designated by the department or program offering the course.

Credit-by-Examination

A graduate student may obtain graduate credit by examination in courses at the 400 level previously identified by the appropriate department or program. As a general rule credit-by-examination is not available for courses at the 600, 700, or 800 levels for, in the judgment of the Graduate Council, courses at these levels require a continuing interaction between faculty and students to achieve the educational goals of advanced study.

A student may receive credit-by-examination only for a course for which he or she is otherwise eligible to receive graduate credit. The department or program in which he or she is enrolled may establish a limit on the number of credits which may be earned through credit-by-examination. A graduate student seeking credit-by-examination must obtain the consent of his or her advisor.

The Graduate School maintains a list of courses for which examinations are available or will be prepared. The fee for credit-by-examination for full-time graduate students is $30.00 per course regardless of the number of credits or units to be earned. Part-time graduate students will be charged the same fee per credit hour they would pay if taking the course in the usual manner.

Transfer of Credit

A maximum of six semester hours of graduate level course credits earned at regionally accredited institutions prior to, or after, matriculation in the Graduate School may be applied toward master's degrees at the University of Maryland. Proportionately larger amounts of credit may be applied toward doctoral degrees.

All graduate study credits offered as transfer credit must meet the following criteria:

1. They must have received graduate credit at the institution where earned.
2. They must not have been used to meet the requirements for any degree previously earned.
3. They must have been taken within the time limits applicable to degrees awarded by the Graduate School.
4. The department or program to which the student has been admitted at Maryland must certify that the courses are appropriate to the degree program the student is pursuing at Maryland.
5. The student earned a B or better in the courses offered for transfer credit.

A student seeking acceptance of transfer credit is advised to submit the necessary transcripts and certification of department or program approval to the Graduate School as promptly as possible for its review and decision.

The Inter-Campus Student

A student admitted to the Graduate School on any campus of the university is eligible to take courses on any other campus of the university with the approval of his or her academic advisor and the graduate deans on the home and host campuses. Credits earned on a host campus are resident credit at the home campus and meet all degree requirements. Transcripts of work taken at another campus will be maintained on the home campus and fees will be paid to the home campus. Forms for effecting registration as an inter-campus student may be obtained from the Graduate School offices on any campus of the university.

Graduate Fees*

Application fee
This fee is not refundable $15.00
Tuition Per Credit Hour:
Resident Student $47.00
Non-Resident Student $77.00

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
(Part Time Student)
Health Fee (Per Semester) . . . $10.00
(Full Time Student)

*The fees listed here are those charged at the time this Catalog went to press and are offered as a general guide. They are subject to change. Fees charged in a particular semester are published in the *Schedule of Classes* for that semester.

Determination of In-State Status for Admission, Tuition and Charge-Differential Purposes

The Board of Regents of the University of Maryland approved new regulations for the determination of in-state status for admission, tuition and charge-differential purposes at its meeting on September 21, 1973. The new regulations become effective with the January 1974 term.

An initial determination of in-state status for admission, tuition and charge-differential purposes will be made by the University at the time a student's application for admission is under consideration. The determination made at that time, and any determination made thereafter shall prevail in each semester until the determination is successfully challenged. *The deadline for meeting all requirements for an in-state status and for submitting all documents for reclassification is the last day of late registration for the semester the student wishes to be classified as an in-state student.*

The implementation of this policy to those eligible for redetermination will require an extended period of time. It is hoped that a decision in each case will be made within ninety (90) days of a request for determination. During this period of time, or any further period of time required by the University, fees and charges based on the previous determination must be paid. If the determination is changed, any excess fees and charges will be refunded.

Persons who are interested in obtaining a copy of the regulations or who wish assistance with their classification should contact: The Graduate School, South Administration Building, University of Maryland, College Park, Maryland 20742—phone (301) 454-5428.

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, college or division. 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.

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 or her graduate program.

To graduate the student must have an average grade of B over all graduate courses taken.

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.

The particular requirements for the degrees of Master of Arts, Master of Science, and Master of Education are given directly below. Those for the degrees of Master of Business Administration, Master of Library Science, and Master of Music are given under "Graduate Programs."

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.

Thesis Requirement

A thesis is required for the Master of Arts and Master of Science degrees except for those programs in which a non-thesis option has been approved by the Dean for Graduate Studies in conformity with the policy of the Graduate Council. Approval of the thesis is the responsibility of an examining committee appointed by the Dean for Graduate Studies. The student's advisor is the chairman of the committee and the remaining members of the committee are members of the graduate faculty who are familiar with the student's program of study. The chairman and the candidate are informed of the membership of the examining committee by the Dean.

A final oral examination on the thesis shall be held when the student has completed his or her thesis to the satisfaction of his or her advisor, providing he or she has completed all other requirements for the degree and has earned a 3.0 grade point average computed in accordance with the regulations described above. The examining committee, with a minimum of three members, conducts the oral examination (an additional comprehensive written examination may be required at the option of the department or program.). The chairman of the examining committee selects the time and place for the examination and notifies other members of the committee and the candidate. Members of the committee must be given a minimum of 7 school days in which to read the thesis.

The duration of the examination is normally about an hour but it may be longer if necessary to insure an adequate examination. The report of the committee, signed by each member, must be submitted to the Dean for Graduate Studies no later than the appropriate date listed in the "Important Dates for Advisor and Students" if the student is to receive a diploma at the Commencement in the semester in which the examination is held.

Directions for the preparation and submission of theses will be found in the *Graduate Student Academic Handbook* which may be purchased at the university book store.

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. Grades for courses not a part of the program but taken in graduate status will be computed in the average.
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 or she can operate as an effective counselor, administrator, teacher, or skilled person in his or her major field of professional endeavor. The program is offered through most of the departments of 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

GENERAL

In addition to the following requirements special departmental or collegiate requirements may be imposed especially in the case of those degrees which are offered in only one department, college or division. 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, college or division.

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 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 or her 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 or her program for the degree, including the dissertation 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 or her 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.

Directions for the preparation and submission of dissertations will be found in the *Graduate Student Academic Handbook* which may be purchased at the university book store.

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

Publication of all or a portion of the dissertation prior to its defense and approval by the Graduate Faculty examining committee requires prior approval of the Dean for Graduate Studies. This approval is sought through a letter to the dean, endorsed by the dissertation advisor, containing an explanation of the need for early publication.

Final Examination

The final oral defense of the dissertation is conducted by a Committee of the Graduate Faculty appointed by the Dean for Graduate Studies. The committee will consist of a minimum of five voting members, all of whom hold the doctoral degree. At least one of the five must hold appointment in a department or Graduate Program external to the one in which the student is seeking the degree. A minimum of three members of the committee must be regular members of the Graduate Faculty of the University of Maryland.

One member of the committee is designated by the dean as his Representative. In addition to having the normal responsibility of a faculty examiner, the dean's representative has the responsibility of assuring that the examination is conducted according to established procedures Any disagreement over the examination procedures is referred to the dean's representative for decision

One or more members of the committee may be persons from other institutions who hold the doctorate and 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 or herself 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 or she 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.

Commencement

Applications 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 the second summer session.

If, for any reason, a student does not graduate at the end of the semester in which he or she applies for the diploma, he or she must re-apply for it in the semester in which he or she 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 University of Maryland student supply store. Orders must be filed eight weeks before the date of commencement but may be cancelled later if the student finds himself or herself unable to complete his or her work for the degree.

Student Services

Housing

There is no on-campus housing provided for unmarried graduate students. The Off-Campus Housing Office (Room 1211H, Student Union, 454-3645), in cooperation with many of the local landlords and apartment managers, maintains an extensive and up-to-date list of vacancies

under several headings (Rooms, Unfurnished Apartments, Houses to Share, etc.). This office can also provide students with convenient maps of the College Park area, and with lists of local motels, trailer and mobile home parks, real estate agents, and furniture rental companies.

The lowest known rates for housing in the area are about $60/month for a room in a house, $135/month for an unfurnished apartment, $150/month for a furnished apartment, and $250/month for a two-bedroom house.

The university itself maintains two apartment complexes for married graduate students and for a limited number of single graduate students. Both Lord Calvert Apartments and University Hills Apartments are within walking distance of campus, which means that there is usually a waiting list, especially during the period immediately preceding the fall semester. Priority for housing in these complexes is currently given to married full-time graduate assistants, then married full-time graduate non-assistants.

Rent for a one-bedroom apartment is about $125/month, with two-bedroom apartments costing about fifteen dollars more; a limited number of efficiencies are available to single students for a slightly lower monthly rent. Students must sign a one year lease and pay a security deposit of $50 (payable when the applicant's name is added to the waiting list). After the initial lease expires, residence in the apartments is on a monthly basis. Graduate students who maintain full-time status are permitted to live in the apartments for a *maximum of five years.*

Information and applications for university-owned housing can be obtained from the Rental Office 3424 Tulane Drive, Hyattsville, Maryland 20783 (422-7445).

University Food Services

The University Food Service offers three dining contract options which are available to graduate students. One plan offers the diner 20 meals per week, the second offers 3 meals/day for five days/week, and the third offers the choice of any 10 meals/week. The 1974-1975 cost of contract dining plans ranged from $297 to $347 per semester. University affiliated people can obtain guest meal tickets for individual meals in contract dining halls for fairly reasonable prices (unlimited quantities for $1.65 at breakfast, $2.00 at lunch, and $2.50 at dinner). More information about contract dining can be obtained from Mr. John Goecker (454-2901).

In addition to the services offered by the contract dining halls, graduate students may wish to take advantage of the cash line services available at the Hill Dining Hall or the various restaurants and snack bars at the Student Union.

Hillel Kosher Dining Club, housed in Hillel House, 7505 Yale Avenue, College Park (277-8961), provides Kosher meals on either a regular or occasional basis.

Health Service

The University Health Center provides routine medical treatment, emergency care, laboratory and x-ray services for all graduate and undergraduate students. The Women's Health Care Unit provides gynecological services and family planning. In addition Mental Health services are available at the Health Center both by appointment and on an emergency basis. Specialty clinics are available in Dermatology and Orthopedics by referral from Health Center physicians. Health Education materials and resources are available through the Health Educator.

The Health Center is open throughout the year, Monday through Friday, 8:00 a.m. to 9:00 p.m. for routine services. Saturday and Sunday hours are 9:00 a.m. to 5:00 p.m. The center is staffed 24 hours a day for emergencies with nurses on duty and a physician is on call at all times. During extended school vacation periods and semester breaks when the center is closed, a physician is available through the campus operator. There is no charge for routine medical care or professional services but charges are made for certain laboratory tests, all x-rays and allergy injections.

Career Development Center

The Career Development Center offers a wide variety of services to graduate students. The goal of the center is to assist students in exploring career opportunities and planning their careers. Services include career advising, the Career Library, the credentials service, and the on-campus interview program.

The career advising program includes both individual and group advising sessions. The Career Library contains occupational information, full-time job listings, employer directories, and other reference sources.

Graduate students are eligible to participate in the on-campus interview program, which involves campus visits by representatives from business, government, and education. Students interested in employment in the fields of education and library science will find the Credentials Service especially valuable.

Counseling Center

The Counseling Center offers consultation on educational/psychological concerns; an open educational-vocational information library; recorded interviews with department heads on the characteristics of graduate majors offered on the campus; and a weekly R & D series of presentations on current educational/psychological topics.

Available services include the following: the Counseling Service, which offers initial consultation on any problems and provides further counseling services or referral services to appropriate individuals or agencies in the area; the Reading and Study Skills Laboratory, for those interested in improving any of their educational skills; the Parent Consultation and Child Evaluation Service, providing a variety of services to the parents of young children with learning or behavior problems; and the Testing, Research and Data Processing Division, which serves as the testing and census taking arm of the campus.

Additional Graduate School Publications

The following is a list of publications available to students who have been admitted to the Graduate School.

GUIDE TO GRADUATE LIFE

A handbook designed to provide the new graduate student with an introduction to the campus and the College Park area, the *Guide* is available from the Office of the Dean for Graduate Studies.

IMPORTANT DATES FOR ADVISORS AND STUDENTS

This calendar card of dates for submission of final documents is available from the various departmental graduate offices, as well as from the Office of the Dean for Graduate Studies.

GRADUATE STUDENT ACADEMIC HANDBOOK

This manual contains the instructions for preparation of dissertations and is available at a nominal cost from the university book store.

Policy of the University of Maryland on Access to and Release of Student Data/Information

General Statement

The University of Maryland has the responsibility for effectively supervising any access to and/or release of official data/information about its students. Certain items of information about individual students are fundamental to the educational process and must be recorded. This recorded information concerning students must be used only for clearly-defined purposes, must be safeguarded and controlled to avoid violations of personal privacy, and must be appropriately disposed of when the justification for its collection and retention no longer exists.

In this regard, the university is committed to protecting to the maximum extent possible the right of privacy of all individuals about whom it holds information, records and files. Access to and release of such records is restricted to the student concerned, to others with the student's written consent, to officials within the university, to a court of competent jurisdiction and otherwise pursuant to law.

Access

All official information collected and maintained in the university identifiable with an individual student will be made available for inspection and review at the written request of that student subject to certain exceptions.

For purposes of access to records at the University of Maryland, a student enrolled (or formerly enrolled) for academic credit or audit at any campus of the university shall have access to official records concerning him on any campus on which he is or has been enrolled.

The personal files of members of the faculty and staff which concern students, including private correspondence, and notes which refer to students, are *not* regarded as official records

of the university. This includes notes intended for the personal use of the faculty and never intended to be official records of the university.

A request for general access to all official records, files and data maintained by a campus, must be made in writing to the coordinator of records or to other person(s) as designated by the chancellor at that particular campus. A request for access to official data maintained in a particular office may be made to the administrative head of that office.

When a student (or former student) appears at a given office and requests access to the university records about himself,

1. The student must provide proper identification verifying that he is the person whose record is being accessed.
2. The designated staff person(s) must supervise the review of the contents of the record with the student.
3. Inspection and review shall be permitted within a period not to exceed 45 days from the date of the student's request.
4. The student will be free to make notes concerning the contents but no material will be removed from the record at the time.

Under normal circumstances, the student is entitled to receive a copy only of his permanent academic record. A reasonable administrative fee may be charged for providing copies of this or other items.

Record keeping personnel and members of the faculty and staff with administrative assignment may have access to records and files for internal educational purposes as well as for routinely necessary clerical, administrative and statistical purposes as required by the duties of thier jobs. The name and position of the official responsible for the maintenance of each type of educational record may be obtained from the coordinator of records or other person appointed by the chancellor on each campus.

Any other access allowed by law must be recorded showing the legitimate educational or other purpose and the signature of the person gaining access. The student concerned shall be entitled to review this information.

Release of Information

Except with the prior written consent of the student (or former student) concerned, or as required by federal and state law, no information in any student file may be released to any individual (including parents, spouse, or other students) or organization with the exception of information defined as "Public Information."

When disclosure of any personally identifiable data/information from university records about a student is demanded pursuant to court order or lawfully issued subpoena, the staff member receiving such order shall immediately notify the student concerned in writing prior to compliance with such order or subpoena.

Data/information from university records about students will be released for approved research purposes only if the identity of the student involved is fully protected.

A record will be kept of all such releases.

Information from university records may be released to appropriate persons in connection with an emergency if the knowledge of such information is necessary to protect the health or safety of a student or other persons.

Public Information

The following items are considered public data information and may be disclosed by the university in response to inquiries concerning individual students, whether the inquiries are in person, in writing or over the telephone.

1. Name
2. Affirmation of whether currently enrolled
3. Campus location

Unless the student has officially filed a request with the campus registrar that disclosure not be made without his written permission, the following items in addition to those above are considered public information and may be included in appropriate university campus directories and publications and may be disclosed by designated staff members in each campus in response to inquiries concerning individual students, whether the inquiries are in person, in writing, or over the telephone.

1. School, college, department, major or division
2. Dates of enrollment
3. Degrees received
4. Honors received
5. Local address and phone number
6. Home address (permanent)
7. Participation in officially recognized activities and sports
8. Weight and height of members of athletic teams

The release of public information as described above may be limited by an individual campus policy.

Letters of Appraisal

Candid appraisals and evaluations of performance and potential are an essential part of the educational process. Clearly, the provision of such information to prospective employers, to other educational institutions, or to other legitimately concerned outside individuals and agencies is necessary and in the interest of the particular student.

Data/information which was part of university records prior to January 1, 1975 and which was collected and maintained as confidential information, will not be disclosed to students. Should a student desire access to a confidential letter of appraisal received prior to January 1, 1975, the student shall be advised to have the writer of that appraisal notify, in writing, the concerned records custodian of the decision as to whether or not the writer is willing to have the appraisal made available for the student's review. Unless a written response is received approving a change of status in the letter, the treatment of the letter as a confidential document shall continue.

Documents of appraisal relating to students collected by the university or any department or office of the university on or after January 1, 1975, will be maintained confidentially only if a waiver of the right of access has been executed by the student. In the absence of such a waiver, all such documents will be available for student inspection and review.

All references, recommendations, evaluations and other written notations or comments, originated prior to January 1, 1975, where the author by reason of custom, common practice, or specific assurance thought or had good reason to believe that such documents and materials would be confidential, will be maintained as confidential, unless the author consents in writing to waive such confidentiality.

If a student files a written waiver with the department or office concerned, letters of appraisal received pursuant to that waiver will be maintained confidentially. Forms will be available for this purpose.

Challenges to the Record

Every student shall have the opportunity to challenge any item in his file which he considers to be inaccurate, misleading or otherwise inappropriate data. A student shall initiate a challenge by submitting a request in writing for the deletion or correction of the particular item. The request shall be made to the custodian of the particular record in question.

If the custodian and the student involved are unable to resolve the matter to the satisfaction of both parties, the written request for deletion or correction shall be submitted by the student to the coordinator of records, or other such person as designated by the chancellor, who shall serve as the hearing officer. The student shall be given the opportunity for a hearing, at which the student may present oral or written justification for the request for deletion or correction. The hearing officer may obtain such other information as he deems appropriate for use in the hearing and shall give the student a written decision on the matter within thirty (30) days from the conclusion of the hearing. If the decision of the hearing officer is to deny the deletion or correction of an item in the student's file, the student shall be entitled to submit a written statement to the hearing officer presenting his position with regard to the item. Both the written decision of the hearing officer and the statement admitted by the student shall be inserted in the student's file. The decision of the hearing officer shall be final.

Grades may be challenged under this procedure only on the basis of the accuracy of their transcription.

Exceptions to the Policy

It is the position of the university that certain data/information maintained in various offices of the university is not subject to the provisions of this policy with regard to inspection, review, challenge, correction or deletion.

(a) Statements submitted by parent/guardian or spouse in support of financial aid or residency determinations are considered to be confidential between those persons and the university, and are not subject to the provisions of this policy except with the written consent of the persons involved. Such documents are *not* regarded as part of the student's official record.

(b) University employment records of students are not included in this policy, except as provided under Article 76A of the Annotated Code of Maryland.

(c) With regard to general health data, only that data/information which is used by the university in making a decision regarding the student's status is subject to review by the student under this policy. Written psychiatric or psychological case notes which form the basis for diagnoses, recommendations, or treatment plans remain

privileged information not accessible to the student. Such case notes are not considered to be part of official university records. To ensure the availability of correct and helpful interpretations of any psychological test scores, notes or other evaluative or medical materials, the contents of these files for an individual student may be reviewed by that student only in consultation with a professional staff member of the specific department involved.

(d) Records relating to a continuing or active investigation by the campus security office, or records of said office not relating to the student's status with the University are not subject to this policy.

(e) No student is entitled to see information or records that pertain to another student, to parents, or to other third parties. A student is entitled to review only that portion of an official record or file that pertains to him or her.

Notice

Notice of these policies and procedures will be published by the university.

The foregoing statement of university policy becomes effective immediately, but should be regarded as tentative pending the issuance of federal regulations and guidelines or amendments in the applicable laws.

The masculine gender of personal pronouns in this document includes the feminine gender.

Approved by the President's Administrative Council, 2/3/75.

University Policy Statement

The provisions of this publication are not to be regarded as an irrevocable contract between the student and the University of Maryland. Changes are effected from time to time in the general regulations and in the academic requirements. There are established procedures for making changes, procedures which protect the intitution's integrity and the individual student's interest and welfare. A curriculum or graduation requirement, when altered, is not made retroactive unless the alteration is to the student's advantage and can be accommodated within the span of years normally required for graduation. When the actions of a student are judged by competent authority, using established procedure, to be detrimental to the interests of the university community, that person may be required to withdraw from the university.

The University of Maryland, in all its branches and divisions, subscribes to a policy of equal educational and employment opportunity for people of every race, creed, ethnic origin, and sex.

It is university policy that smoking in classrooms is prohibited unless all participants agree to the contrary. Any student has the right to remind the instructor of this policy throughout the duration of the class.

Important Late Information on Fees and Expenses

All Students Who Pre-Register Incur a Financial Obligation to the University. Those students who pre-register and subsequently decide not to attend must notify the Registration Office, Room 1130A, North Administration Building, in writing, prior to the first day of classes. If this office has not received a request for cancellation by 4:30 p.m. of the last day before classes begin, the University will assume the student plans to attend and accepts his financial obligation.

After classes begin, students who wish to terminate their registration must follow the withdrawal procedures and are liable for charges applicable at the time of withdrawal.

State of Maryland legislation has established a State Central Collections Unit and in accordance with State law the University is required to turn over all delinquent accounts to them for collection and legal follow-up. These are automatically done on a monthly basis by computer read-out.

The Graduate Faculty

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Carroll, Stephen J., Jr., Professor of Business Organization and Administration
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Carter, Dan T., Professor of History
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Administration, Supervision and Curriculum Program

Professor and Chairman: Stephens
Professors: Anderson, Berman, Carbone, Dudley, James, McClure, Newell, Perrin, Van Zwoll, Wedberg, Wiggin
Associate Professors: Goldman, Kelsey, McLoone,[1]
Assistant Professors: Bennett, Splaine, Statom

[1]joint appointment with Economics

The Department of Administration, Supervision and Curriculum offers programs of study for the M.A., M.Ed., Ed.D., and Ph.D. 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, A.G.S., 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 or its equivalency, is required of all doctoral 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 Utilization of Educational Media. (3) Survey of classroom uses of instructional media. Techniques for integrating media into instruction. Includes preparation of a unit of instruction utilizing professional and teacher produced media.

EDAD 441 Graphic Materials for Instruction. (3) Prerequisite, EDAD 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 EDAD 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 are developed through the television 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.

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 multi-disciplinary 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, EDAD 440. Review of research in educational technology and mass media of communication which relates to the instructional process; learning theory implications, sociological and economic considerations.

EDAD 641 Selection and Evaluation of Instructional Media. (3) Development of criteria for selection and evaluation of instructional materials for classroom, school and system use; includes measures of readability, listenability, visual difficulty, and interest level.

EDAD 642 Mediated Instructional Systems. (3) Prerequisite, EDAD 440 and EDAD 444. Survey of innovative instructional systems. Comparison of effectiveness of alternate teaching-learning systems. System design to improve teaching-learning efficiency through instructional media.

EDAD 644 Practicum in Instructional Systems. (2-6) Prerequisite, EDAD 444 or EDAD 642. Design and development of experimental instructional materials or systems 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 shcool 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) Registration required to the extent of six hours for master's thesis.

EDAD 802 Curriculum in Higher Education. (3) An 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 twenty (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 of 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 twenty (20) semester hours.

EDAD 899 Doctoral Dissertation Research. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Aerospace Engineering Program

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

The Aerospace Engineering Department offers a broad program of graduate studies leading to the degrees of Master of Science and Doctor of Philosophy. Applications for admission are invited from those holding a B.S. degree in engineering, the physical sciences, and mathematics. 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. Within these areas of specialization, the student can tailor programs such as Aircraft and Aerospace Vehicle Design, Naval Architecture, Computational Mechanics, and High Temperature Gas Dynamics.

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

For the Doctor of Philosophy degree, the Aerospace Engineering Department requires 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 a Univac 1106 and a Univac 1108 complemented by remote access units on a time-sharing basis are available. The Department provides special facilities for the use of students which include remote terminals and minicomputers. Under special circumstances, thesis research may be accomplished in off-campus research facilities.

A number of graduate assistantships and fellowships are available for financial assistance.

ENAE 401 Aerospace Laboratory II. (2) One lecture and one laboratory per week. Prerequisites, ENAE 305 and ENAR 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 per 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 431 Computer Aided Structural Design Analysis. (3) Two lectures and one laboratory per week. Prerequisites, ENAE 352 or equivalent. Introduction to structural design concepts, analysis techniques, and computer software for structural analysis which is utilized to verify closed form solutions and perform parametric studies.

ENAE 445 Stability and Control of Aerospace Vehicles. (3) Three lectures per week. Prerequisite, ENAE 345 and ENAE 371. Dynamic 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. Dynamic 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 215 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. Prerequisite, 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 471, and ENME 216. Required course for aerospace seniors. Fundamental aspects of viscous flow, Navier-Stoles 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 361, 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; and introduction to shell theory.

ENAE 652 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; and introduction to shell theory.

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 structure. Wing divergence and aileron reversal. Theory of two dimensional oscillating airfoil. Flutter problems. Random vibrations.

ENAE 656 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 structure, wing divergence and aileron reversal. Theory of two dimensional oscillating airfoil, flutter problems, random vibrations.

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) 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 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) 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 673 Aerodynamics of Compressible Fluids. (3) Prerequisite, ENAE 372 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) Prerequisite, ENAE 372 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 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.

ENAE 676 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 to turbulent flow, turbulent flow-isotropic turbulence, boundary layer flows, free mixing flows.

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, non-linear systems, random vibrations and structural failure from random loads.

ENAE 757 Advanced Structural Dynamics II. (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, non-linear systems, random vibrations and structural failure from random loads.

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 frot he 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) 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 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)

Agricultural and Extension Education Program

Acting Chairman: Poffenberger
Professors: Longest, Nelson, Ryden
Assistant Professors: Seibel, Wheatley, Wright

As a multidisciplinary department of several educational and social science specialities, 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) The agricultural extension service is an educational agency. The history, philosophy, objectives, policy, organization, legislation and methods used in extension work.

RLED 423 Extension Communications. (3) An introduction to communications in teaching and within an organization, including barriers to communication, the diffusion process and the application of communication principles person to person, with groups and through mass media.

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 427 Group Dynamics in Continuing and Extension Education. (3) Concepts involved in working with groups planning extension and continuing education programs. Analysis of group behavior and group dynamics related to small groups and development of a competence in the selection of appropriate methods and techniques.

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 season.

RLED 488 Critique in Rural Education. (1) Current problems and trends in rural education.

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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 season.

RLED 499 Special Problems. (1-3) Prerequisite, staff approval.

RLED 606 Program Planning and Evaluation in Agricultural Education. (2-3) Second semester. 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 implimentation in the 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. Repeatable to a maximum of five credits.

RLED 642 Continuing Education in Extension. (3) Studies 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. (1-3) Problems in the organization, administration, and supervision of the several agencies of rural and/or vocational education. Repeatable to a maximum of eight semester credits.

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: Abrahamsen, Beal, Bender, Foster, Ishee, Lessley, Moore, Murray, Poffenberger, Smith, Stevens, Tuthill, Wysong
Associate Professors: Cain, Hardie, Lawrence, Marasco, Via
Assistant Professors: Bellows

The Department of Agricultural and Resource Economics offers two programs of work leading to the Master of Science and Doctor of Philosophy degrees. Under the traditional curriculum, students may pursue work in production economics, foreign economic development, international trade, agricultural marketing, farm management, public policy and fisheries economics.

A second program in Resource Management and Development offers students the opportunity to integrate study from a wide variety of disciplines related to the economics of resource use. Possible specializations in the program are water resources, marine resources, land use or some other aspect of environmental management.

Thesis and non-thesis options are available for the Master of Science degree in both programs. The thesis option requires a minimum of 24 hours of course work; 33 hours of course work for the non-thesis option. Students taking the non-thesis option in Resource Management are urged to participate in a two or three month internship with some public or private planning agency.

Applicants with strong undergraduate records in diverse fields are considered for admittance to both Master of Science programs. Necessary course prerequisites (without credit) can be completed after admittance. No entrance examinations are required, but three letters of recommendation must be submitted.

Students with bachelor's degrees may apply for the doctoral programs, though they are encouraged to complete requirements for the M.S. degree. Applicants holding a master's degree in an equivalent field from an accredited institution may be admitted for immediate doctoral study. A minimum of 18 hours of course work beyond the master's level is required for the Ph.D. degree in both programs in addition to 12 hours of dissertation research. Qualifying examinations are administered on completion of basic course requirements and written and oral comprehensive examinations are held when all course work has been completed. A final oral examination is held for the student tc defend the dissertation. There is no foreign language requirement for any graduate degree.

Graduate assistantships are offered to qualified applicants on the basis of past academic performance and experience. Approximately one-half of full-time students in the department hold assistantships or some form of financial aid. Part-time and summer work is often available for students not receiving financial aid.

The department actively employs the resources of the many state, federal, and international agencies in the area to offer research and/or internship experiences designed to give competency in making observations from the real world. The course work of the various programs familiarizes the student with traditional subject matter, and seminar and discussion opportunities enable the student to sharpen the 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 ot parity and the role ot price support programs in agricultural decisions.

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 devoted to field trips and other practical exercises.

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.

AREC 410 Horse Industry Economics (3)- Prerequisite, ANSC 230 and 232. An introduction to the economic forces affecting the horse industry and to the economic tools required by horse farm managers, trainers, and others in the industry.

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.

AREC 427 The Economics of Marketing Systems for Agricultural Commodities (3)- Basic economics theory as applied to the marketing of agricultural products, including price, cost, and financial analysis. Current developments affecting market structure including effects of contractual arrangement, vertical integration, governmental policies and regulation.

AREC 432 Introduction to Natural Resources Policy (3) Development of natural resource policy and analysis of the evolution of public intervention in the use of natural resources. Examination of present policies and of conflicts between private individuals, public interest groups, and government agencies.

AREC 445 World Agricultural Development and the Quality of Life (3) An examination of the key aspects of the agricultural development of less developed countries related to resources, technology, cultural and social setting, population, infrastructure, incentives, education, and government. Environmental impact of agricultural development, basic economic and social characteristics of peasant agriculture, theories and models of agricultural development, selected aspects of agricultural development planning.

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.

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.

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.

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.

AREC 489 Special Topics in Agricultural and Resources Economics (3) Repeatable to a maximum of 9 credits.

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 and resource 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 by the examination of modern problems in agricultural and resource 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 and resource 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 hours.

AREC 689 Special Topics in Agricultural and Resource Economics (3) First and second semester. Subject matter taught will be varied and will depend on the persons available for teaching unique and specialized phases of agricultural and resource economics. The course will be taught by the staff or visiting agricultural and resource economists who may be secured on lectureship or visiting Professor basis.

AREC 698 Seminar (1) First and second semesters. 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.

AREC 699 Special Problems in Agricultural and Resource Economics (1-2) First and second semesters and Summer. Intensive study and analysis of specific problems in the field of agricultural and resource economics, which provide information in depth in areas of special interest to the student.

AREC 799 (1-6) Master's thesis research.

AREC 804 Advanced Agricultural Price and Demand Analysis (3) Second semester. 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.

AREC 806 Economics of Agricultural Production (3) First semester. 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-ouput analysis.

AREC 824 Food Distribution Management (3) Theory and practice of the complex functional and institutional aspects of food distribution systems analyzed from the perspective of management decision-making in the food industry. Possible long range economic effects of current structural adjustments: social and ecological aspects of food industry management decision-making.

AREC 832 Agricultural Price and Income Policy (3) Second semester, alternate years, 1973. The evolution of agricultural policy in the United States, emphazing the origin and development of governmental programs, and their effects upon agricultural production, prices and income.

AREC 844 Advanced Theory and Practice of International Agricultural Trade (3) Second semester. 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.

AREC 845 Agriculture in World Economic Development (3) First semester, alternate years, 1972. 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.

AREC 852 Advanced Resource Economics (3) Second semester, alternate years. 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.

AREC 883 Agricultural and Resource Economics Research Techniques (3) First semester. Emphasis is given to philosophy and basic objectives of research in the field of agricultural and resource 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 and resource economics. 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)

Agricultural Engineering Program

Professor and Acting Chairman: Harris
Professors: Green, Winn
Associate Professors: Cowan, Felton, Hummel, Merkel, Wheaton
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 degree 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) 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) 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) 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.

AGEN 422 Soil and Water Engineering. (3) Three lectures per week. Prerequisite, ENME 340. 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.

AGEN 424 Functional and Environmental Design of Agricultural Structures. (3) Two lectures and one hour laboratory per week. Prerequisite, 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.

AGEN 432 General Hydrology. (3) Three lectures per week. Qualitative aspects of basic hydrologic principles pertaining to the properties, distribution and circulation of water as related to public interest in water resources.

AGEN 433 Engineering Hydrology. (3) Three lectures per week. Prerequisites, MATH 246, ENCE 330 or ENME 340. Properties, distribu-

tion 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

AGEN 435 Aquacultural Engineering. (3) Prerequisite, consent of department. A study of the engineering aspects o f development. Utilization and conservation of aquatic systems Emphasis will be on harvesting and processing aquatic animals or plants as related to other facets of wafer resources management.

AGEN 488 Topics in Agricultural Engineering Technology. Prerequisite, permission of the instructor. Selected topics in agricultural engineering technology of current need and interest. May be repeated to a maximum of six credits if topics are different. Not acceptable for credit towards major in agricultural engineering.

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 Agricultural Engineering Technology. (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 and techniques for research and operational agricultural or biological systems

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

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 aquisition, project analysis and engineering economy.

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 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 analyses, 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) First semester, 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) Second semester, 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) Spring semester. Prerequisite, AGRI 602 or its equivalent. The course is intended to provide the graduate student with a working knowledge of statistical methods used in biological assay Topics to be considered will include 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) First semester, 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 of least squares procedures for the analysis of data with unequal subclass numbers.

AGRI 702 Experimental Procedures in the Agricultural Sciences. (3) First semester 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, Burt, Caldwell (visiting), Fanning, Parochetti
Assistant Professors: Hall, Johnson, Mulchi, Wolf

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. Programs are offered in cereal crop production, forage management, turf management, plant breeding, tobacco production, crop physiology, weed science, soil chemistry, soil physics, soil fertility, soil and water conservation, soil classification, soil survey and land use, soil mineralogy, soil biochemistry, soil microbiology, air pollution, waste disposal, and soil-environment interactions.

Thesis and non-thesis options are available for the Master of Science degree. A bachelor's degree in Agronomy is not required if the student has adequate training in the basic sciences. All students must complete the Master of Science degree before admission to the doctoral program. Departmental regulations have been assembled for the guidance of candidates for graduate degrees. Copies of these regulations are available from the Department of Agronomy.

The Agronomy Department has over 20 well-equipped laboratories to carry out basic and applied research in crop and soil science. Basic equipment in the laboratories includes: X-ray diffraction and spectrograph units, atomic absorption spectrophctometer, gas chromatograph, isotope counters, petrographic microscopes, neutron soil moisture probe and scaler, and carbon furnace. Growth chambers, extensive greenhouse space, and five research farms permit a wide range of environmental conditions for research into plant growth processes. A computer center, located on campus, is available for use by the department. The University and the new National Agricultural Sciences Libraries, supplemented by the Library of Congress, make the library resources among the best in the nation. 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.

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.

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.

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.

AGRO 407 Cereal Crop Production (2) Prerequisite, BOTN 100, AGRO 100 or concurrent enrollment therein. Study of the prin-

ciples and practices of corn, wheat, oats, barley, rye, and soybean production.

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.

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.

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.

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.

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.

AGRO 417 Soil Physics (3) Two lectures and one laboratory period a week. Prerequisite, AGRO 202 and a course in physics, or permission of instructor. A study of physical properties of soils with special emphasis on relationship to soil productivity.

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.

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.

AGRO 452 Seed Production and Distribution (2) One lecture and one laboratory period a week. Prerequisite, AGRO 102 equivalent. 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.

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.

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) Alternate years (offered 1973-74). Prerequisite, AGRO 403 or equivalent. Genetic, cytogentic, 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.

AGRO 602 Advanced Crop Breeding (2) Alternate years (offered 1973-74). Prerequisite, AGRO 601 or equivalent. Genetic, cytogentic, 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.

AGRO 608 Research Methods.(2) Second Semester. 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) Second Semester, Alternate years (offered 1972-73). 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 of minor elements necessary for plant growth.

AGRO 789 Recent Advances in Agronomy (2-4) First semester. 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) First and second semesters. 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) Second semester, alternate years (offered 1972-73). 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.

AGRO 804 Technic in Field Crop Research (2) Second semester, alternate years (offered 1972-73). Field Plot technique, application of statistical analysis to agronomic data, and preparation of the research project.

AGRO 805 Advanced Tobacco Production (2) First semester, alternate years (offered 1973-1974). Prerequisite, permission of instructor. A study of the structural adaption and chemical response of tobacco to environmental variations. Emphasis will be placed on the alkaloids and other unique components.

AGRO 806 Herbicide Chemistry and Physiology (2) Second semester, alternate years (offered 1972-1973). 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.

AGRO 807 Advanced Forage Crops (2) First semester, alternate years (offered 1972-1973). 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.

AGRO 821 Advanced Methods of Soil Investigation (3) First semester, alternate years (offered 1973-1974). 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.

AGRO 831 Advanced Soil Mineralogy (3) First semester, alternate years (offered 1972-1973). 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.

AGRO 832 Advanced Soil Physics (3) Second semester, alternate years (offered 1973-1974). Prerequisites, AGRO 202 and permission of instructor. An advanced study of physical properties of soils.

AGRO 899 Doctoral Dissertation Research (1-8)

American Studies Program

Associate Professor and Chairman: Lounsbury
Professors: Beall, Corrigan
Associate Professor: Mintz

The American Studies Program, offering the M.A. and Ph.D. degrees, provides a unique combination of opportunities for the individual

seeking to study our civilization at the graduate level: 1) an academic community located near the nation's capital; 2) a faculty, trained in American Studies, that offers courses where the student may integrate a variety of cultural materials and pursue his speculations through the channels of interdisciplinary scholarship; 3) the availability of courses, emphasizing American materials, in the traditional departments of Anthropology, Architecture, Art, Economics, Education, English, Geography, Government and Politics, History, Journalism, Music, Philosphy, Psychology, Speech and Dramatic Arts.

The proximity of many federal institutions allows for a firsthand appreciation of politics and contemporary life, while the facilities of the National Archives and the Library of Congress give the historian access to the materials documenting the experiences of past generations. Important galleries, including the National Collection of Fine Arts and the National Gallery of Art, exhibit the high points of creative expression in the visual arts. The holdings of the Smithsonian Institution possess numerous manifestations of the native vernacular traditions in architecture and technology, in the folk arts, and in American Indian culture. The District of Columbia and its surrounding regions represent an impressive aggregate of associations and communities—alternatives to traditional politics such as Common Cause, the focus upon black cultural identity found in the Anacostia Neighborhood Museum, the new cities of Columbia, Maryland, and Reston, Virginia which seek to transcend the crises of urban America in a creative manner.

The program, drawing upon the resources of its cultural environment, offers the individual an education in the most meaningful sense: a personal confrontation with academic tradition related to the processes of immediate and contemporary social change.

The new graduate candidate encounters a community of students who represent a rewarding diversity of backgrounds, most prominently from the fields of history, literature and American civilization but also from such disciplines as psychology, political science, art, and sociology.

The proseminar in American Studies embodies much of the philosophy of the graduate program: it allows the new major to share the perceptions he has gained in his undergraduate training. He is introduced to methodology stressing the value of art, literature, technology, popular culture, and anthropology in the observation of cultural patterns. All of the reading assignments, although they display different terminology and writing styles, are evaluated in terms of the authors' endeavors to expand the role of the intellectual in the academy and in American society. Lastly, the proseminar introduces each participant to alternatives of focus in his future research and reading.

The more advanced American Studies seminars vary from semester to semester so that both students and faculty may explore new directions for illuminating a certain segment of our civilization. Frequently, the seminars concentrate on a specific period of American culture—Antebellum America, The Gilded Age, The 1930s, The 1960s—or emphasize thematic materials calling for a multiperspective methodology—Myths and Symbols of the Communications Revolution, Humor and Satire in American Life, or National Identity in the United States. An important feature of the graduate program is the Smithsonian Institution, where the serious student of material artifacts can take advantage of the seminars, exhibits and independent reading courses prepared by a highly trained staff.

The master's degree candidate, who will normally undertake a full year of course work (30 semester hours), possesses a number of alternatives from which to choose a program meeting his professional needs and intellectual preoccupations. In addition to the American Studies seminars, he selects an area of concentration in one of the departments listed above. Once he has met the specific requirements (9 hours in American Studies, 9 hours in a single department) for the degree, he may pursue his interests in the traditional disciplines or he may select a sequence of courses suggesting new perspectives on the interaction of the personality and the environment, including classes from departments which address themselves to minority group behavior, to an evaluation of the mass media's impact on the human sensibility, or to a consideration of global patterns emerging in Europe, Africa and Asia.

Before receiving the M.A. degree, the candidate takes a comprehensive examination drawing upon his ability to integrate the materials of his particular program. Research oriented majors may wish to write a thesis in place of six hours of course credit.

The requirements for the doctoral degree are flexible and enable the candidate to complete his course work within a year of intensive study (30 semester hours beyond the M.A., including an 18-credit residency requirement). The student also demonstrates his proficiency in a foreign language or in an analytical tool such as computer science, successfully completes a comprehensive examination, and submits a thesis giving evidence of original research and interpretation.

Other than an additional seminar in methodology, the candidate has no specific course requirements unless he has received his master's degree from another institution. Under those circumstances, he enters the appropriate seminars in American Studies and prepares for a qualifying oral examination during his first year of residence.

If any student wishes to consider a topic which is not found in formal classes at the university, he is free to construct a reading program with the guidance of a faculty member in American Studies or in one of the related disciplines. The comprehensive examination is based on three separate segments of study: theories and methods in American Studies; an area of concentration (usually in American history or literature); a specialized field related to the themes and time span to be investigated in the dissertation (for example Popular Culture, Afro-American Studies, American Thought, American Art and Technology, Urban Studies, Women's Studies).

The American Studies thesis is therefore the logical extension of the courses and examination areas decided upon by the graduate student himself. In the dissertation, he will employ his sense of historical continuity and cultural interaction to illuminate some segment of American society.

AMST 426 Culture and the Arts in America (3) Prerequisite, junior standing. A study of American institutions, the intellectual and esthetic climate from the colonial period to the present.

AMST 427 Culture and the Arts in America (3) Prerequisite, junior standing. A study of American institutions, the intellectual and esthetic climate from the colonial period to the present.

AMST 436 Readings in American Studies (3) Prerequisite, junior standing. An historical survey of American values as presented in various key writings.

AMST 437 Readings in American Studies (3) Prerequisite, Junior standing. An historical survey of American values as presented in various key writings.

AMST 446 Popular Culture in America (3) Prerequisite, junior standing and permission of instructor. A survey of the historical development of the popular arts and modes of popular entertainment in America.

AMST 447 Popular Culture in America (3) Prerequisite, junior standing and AMST 446. Intensive research in the sources and themes of contemporary American popular culture.

AMST 618 Introductory Seminar in American Studies (3)

AMST 628 Seminar in American Studies (3)

AMST 629 Seminar in American Studies (3)

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)

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: The topics 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 or 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 410 Contemporary African Ideologies (3) Analysis of contemporary African ideologies. Emphasis on philosophies of Nyerere, Nkrumah, Senghor, Sekou Toure, Kaunda, Cabral, et al. Discussion of the role of African ideologies on modernization and social change.

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 inter-disciplinary 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.

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, livestock production, and some areas of wildlife ecology.

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.

More detailed information about specific disciplinary programs may be requested from individual faculty members who advise graduate programs in a particular area.

Disciplinary or Subject Area	Faculty Advisor
Nutrition, Ruminant	E C Leffel, J V DeBarthe
Nutrition, Horses	E C Leffel
Nutrition, Swine	E P Young
Physiology, Nutritional, comparative	J V DeBarthe
Physiology, Reproductive, comparative	J V DeBarthe
Physiology, Reproductive, horses	J P McCall
E E Goodwin, J P McCall	
Food Science, Red Meats	John Buric
Wildlife Ecology	Vagn Flyger

Adequate course offerings are available to structure programs to meet individual needs. Programs are developed by students in consultation with an advisor or advisory committee. Animal Science courses are offered in the areas of animal breeding, nutrition, management, and physiology. Additional specialized physiology courses are offered in the Zoology Department and are usually included in nutrition and physiology programs. Excellent supportive courses in biochemistry are available in the Chemistry Department. The courses in biometrics (catalog listing AGRI or Agriculture) provide excellent background in experimental design and statistical analysis. The Computer Science Center offers courses in programming and computer language as well as facilitates for the statistical analyses of thesis data.

Excellent laboratory facilities are available in the Animal Sciences Center which provide the combined resources of the Animal Science, Dairy Science, Poultry Science, and Veterinary Science Departments. Instrumentation is available to graduate students for gas-liquid chromatography, atomic absorption spectrophotometry, automated calorimetry, electron microscopy, liquid scintillation radioactivity measurements, electrophoresis, and a variety of microbiological techniques. Controlled environment facilities in the center permit work with laboratory animals and detailed experiments on larger animals. A gnotobiote laboratory is also available and is currently being used in ruminant nutrition research. Excellent surgical facilities are available for research in the areas of reproductive and nutritional physiology.

The department's herds and flocks of beef cattle, horses, sheep, and swine are readily available for graduate research. Small-scale experiments can be conducted on the campus, and those requiring more extensive facilities are located at one of three outlying farms.

Minimum requirements for admission are a B.S. in animal science or biology with a grade point average of 3.0 (4 = A). Applicants not meeting these requirements are considered for provisional admission. Applicants who do not meet minimum grade requirements, but have demonstrated definite improvement during the later part of their undergraduate career, particularly in animal science and other science courses, are frequently given favorable consideration for provisional admission. Applicants lacking undergraduate preparation in animal science and biology may overcome this deficiency, by enrolling for course work only prior to admission to a degree program. The Graduate Record Examination is not required, but high scores on this examination may compensate for a mediocre undergraduate record.

A limited number of assistantships are available and are awarded to those students presenting strong academic records. Vacancies occur irregularly depending upon degree completion or status changes of incumbents.

The Master of Science program can be completed within one and one-half to two years. The thesis option requires a minimum of 24 credits of course work and 6 credits of research. The non-thesis option with a minimum of 30 credits of course work may be completed more rapidly than the thesis option. The Ph.D. programs are typically completed in a period of three to five years. There is no specific credit-hour requirement for the doctorate. The qualifying examination for the Ph.D. is scheduled when the student and the major advisor decide that sufficient course-work and planning for the dissertation research have been completed. The committee for qualifying examinations is approved by the departmental graduate committee in consultation with students' advisors. The master's degree is not prerequisite for admission to the doctoral program.

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 anaimals and man will be considered.

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

ANSC 403 Applied Animal Nutrition. (3) Two lectures and one laboratory period per week. Prerequisities, MATH 110, ANSC 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 rations will be presented.

ANSC 406 Environmental Physiology. (3) Prerequisites, Anatomy and 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.

ANSC 407 Advanced Dairy Production. (1) 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 three-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.

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.

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.

ANSC 414 Biology and Management of Fish. (4) Prerequisite, one year of Biology or Zoology. Two lectures and two three-hour laboratories a week. Fundamentals of individual and population dynamics, theory and practice of sampling fish populations, management schemes.

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.

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.

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

ANSC 426 Principles of Breeding. (3) Second semester. 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.

ANSC 432 Horse Farm Management. (3) Prerequisite, ANSC 332 and AREC 410. One 90-minute lecture and one four-hour laboratory period per week. A course to develop the technical and managerial skills necessary for the operation of a horse breeding farm. Herd health programs, breeding programs and procedures, foaling activities, foot care, weaning programs, and the maintenance of records incidental to each of these activities.

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.

ANSC 444 Analysis of Dairy Production Systems. (3) Prerequisites, AGEC 405 and ANSC 203 or 214, 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.

ANSC 446 Physiology of Mammalian Reproduction. (3) Two lectures and one three-hour laboratory period per week. Prerequisite, ZOOL 422 or ANSC 212. Anatomy and physiology of reproductive processes in wild and domesticated mammals.

ANSC 452 Avian Physiology. (2) Alternate even years, one three-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.

ANSC 454 Ornithology for Teachers. (3) Three hours of lecture with occasional laboratory and field exercises. Prerequisite, three college-level Zoology courses, avian morphology, anatomy, adaptations, behavior, development, life histories, classification, ecology, management, and evolution. Individual and classroom special projects.

ANSC 462 Physiology of Hatchability. (1) Two lectures and one 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.

ANSC 463 Nutrition Laboratory. (2) Prerequisite, ANSC/NUSC 401 or concurrent registration. Six hours of laboratory per week. Digestibility studies with ruminant and monogastric animals, proximate analysis of various food products, and feeding trials demonstrating classical nutritional deficiencies in laboratory animals.

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.

ANSC 466 Avian Anatomy. (3) Two lectures and one laboratory period per week. Prerequisite, ZOOL 102. Gross and microscopic structure, dissection and demonstration.

ANSC 467 Poultry Breeding and Feeding. (1) 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. (1) 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. 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) First semester. One one-hour lecture and one-three hour laboratory per week. Prerequisite, permission of instructor. Physiological, microbiological and biochemical aspects of the nutrition of ruminants as compared to other animals.

ANSC 603 Mineral Metabolism. (3) Second semester. Two 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.

ANSC 604 Vitamins. (3) Prerequisites, ANSC 401 and CHEM 461. Two one-hour lectures and one two-hour discussion period per week. Advanced study of the fundamental role of vitamins and vitamin-like cofactors in nutrition including chemical properties, absorption, metabolism, excretion and deficiency syndromes. A critical study of the biochemical basis of vitamin function, interrelationship of vitamins with other substances and of certain laboratory techniques.

ANSC 610 Electron Microscopy. (4) First and second semesters. 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.

ANSC 612 Energy Nutrition. (2) Second semester. Prerequisites, ANSC 402 or NUSC 450, CHEM 461, or consent of instructor. One lecture, one 2 hour laboratory per week. Basic concepts of animal energetics with quantitative descriptions of energy requriements and utilization.

ANSC 614 Proteins. (2) Second semester. One lecture and one 2 hour laboratory per week. Prerequisites, ANSC 402 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.

ANSC 622 Advanced Breeding. (2) Second semester, alternate years. 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.

ANSC 641 Experimental Mammalian Surgery I. (2) First semester. 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) Second semester. 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 are taught.

ANSC 643 Research Methods. (3) First semester. 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) First and second semesters. Readings on individual topics are assigned. Written reports required Methods of analysis and presentation of scientific material are discussed

ANSC 661 Physiology of Reproduction. (3)- First semester. 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

ANSC 663 Advanced Nutrition Laboratory. (3) Prerequisite, ANSC/NUSC 401, and either CHEM 462 or NUSC 670. One hour of lecture and six hours of laboratory per week. Basic instrumentation and techniques desired for advanced nutritional research. The effect of various nutritional parameters upon intermediary metabolism. Enzyme kinetics, endocrinology, and nutrient absorption in laboratory animals.

ANSC 665 Physiological Genetics of Domestic Animals. (2) Second semester. 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

ANSC 677 Advanced Animal Adaptations to the Environment. (2) First semester. 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 or Domestic Animals. (3) Second semester 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

ANSC 698 Seminar. (1) First and second semesters. 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; (1) nutrition; (3) physiology; (4) biochemistry.

ANSC 699 Special Problems in Animal Science. (1-2) First and second semesters. 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)

Interdisciplinary Applied Mathematics Curriculum

Professors: Almon (ECON), Antman (MATH), Babuska (IFDAM), Banerjee (PHYS), Brill (PHYS), Cadman (CHE), Cunniff (ME), Davidson (PHYS), DeClaris (EE,IFDAM), Dorfman, (IFDAM), Douglas (MATH), Edmundson (CSD), Greenberg (PHYS), Hubbard (IFDAM), G.S. Jones (IFDAM), Kanal (CSD), Karlovitz (IFDAM), Kellogg (IFDAM), Krall (PHYS), Misner (PHYS), Newcomb (EE), Olver (IFDAM), Ortega (CSD), Pearl (MATH), Prange (PHYS), Rheinboldt (CSD), Stellmacher (MATH), Strauss (MATH), Sucher (PHYS), Weiss (EE, IFDAM), Yorke (IFDAM), Zwanzig (IFDAM).

Associate Professors: Cooper (MATH), Donaldson (AERO), Dragt (PHYS), Fivel (PHYS), Garber (CE), Gentry (CHE), Hall (CE), Johnson (MATH), E. Jones (AERO), Kim (PHYS), Schneider (MATH), Sheaks (CHE), Sternberg (CE), Sweet (MATH), Vandergraft (CSD), Wolfe (MATH), Woo (PHYS).

Assistant Professors: Agrawala (CSD), Anderson, Jr. (MATH), Baras (EE), Berenstein (MATH), Ephremides (EE), Kugelman (CHE), Liu (MATH), MacRae (ECON), Schmidt (MATH), McClellan (CSD).

The Interdisciplinary Applied Mathematics Curriculum at the University of Maryland in College Park is designed to provide opportunities for graduate study and research in mathematics and its applications in the engineering, physical and social sciences. Problems in nearly all of the scientific disciplines are amenable to mathematical treatment, and the tools used come from all of the branches of mathematics. In the Curriculum, a student can select a coherent program from a variety of specializations tailored to his particular interests. The goal is to produce an applied mathematician with demonstrated ability in mathematics as well as in some appropriate field of application.

The Curriculum is administered and taught by a selected faculty from ten Participating Departments on the College Part Campus. The participating departments are: Aerospace Engineering Department; Chemical Engineering Department; Civil Engineering Department; Computer Science Department; Economics Department; Electrical Engineering Department; Institute for Fluid Dynamics and Applied Mathematics; Mathematics Department; Mechanical Engineering Department; Physics and Astronomy Department.

For admission to the Interdisciplinary Applied Mathematics Curriculum, the student should—in addition to the general admission requirements of the Graduate School—have completed an undergraduate program which included a strong emphasis on mathematics. A student may enter the Curriculum in one of two ways: namely, by applying for admission either directly to the Interdisciplinary Applied Mathematics Curriculum itself, or to one of the participating departments of the Curriculum listed below. In general this choice will reflect the background of the applicant However, if any financial assistance is desired, the application should be made through one of the participating departments of the Curriculum.

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.

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.

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.

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.

ANTH 423 Ethnology of the Southwest. (3) Prerequisites, ANTH 101 and 102. Culture history, economics and social institutions, religion, and mythology of the Indians of the Southwest United States.

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.

ANTH 426 Ethnology of Middle America. (3) Prerequisites, ANTH 101 and 102. Cultural background and modern social, economic and religious life of Indian and Mesitzo groups in Mexico and Central America; processes of acculturation and currents in cultural development.

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.

ANTH 436 Primitive Technology and Economy. (3) A survey of technology, food economy and general economic processes in non-industrial societies.

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.

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.

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.

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.

ANTH 498 Field Methods in Ethnology. (1-6) Field training in the collection and recording of ethnological data.

ANTH 499 Field Methods in Archaeology. (1-6) Field training in the techniques of archaeological survey and excavation.

ANTH 605 Theory of Cultural Anthropology. (3) History and current trends of cultural anthropological theory, as a basic orientation for graduate studies and research.

ANTH 621 Cultural Ecology. (3) Prerequisite, permission of instructor. An examination of the nature of the interrelationships between human cultures and the natural environmentals in which they exist.

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.

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.

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.

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.

ANTH 681 Processes of Culture Change. (3) Change in culture due to contact, diffusion, novation, fusion, integration, and cultural evolution.

ANTH 685 Peasant Communities in the Modern World. (3) Comparative analysis of peasant communities in Latin America, Europe, Middle East, Asia and Africa.

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)

ANTH 698 Advanced Field Training in Ethnology. (1-6) Offered in the summer session only.

ANTH 699 Advanced Field Training in Archaeology. (1-6) Offered in the summer session only.

Architecture Courses

ARCH 400 Architecture Studio III. (4) Prerequisites, ARCH 301 with a grade of C or better, and ARCH 311. Corequisite, ARCH 410, except by permission of the Dean. Continuation of Design Studio, with emphasis on comprehensive building design and introduction to urban design factors. Lecture and studio 9 hours per week.

ARCH 401 Architecture Studio IV. (4) Prerequisites, ARCH 400 with a grade of C or better and ARCH 410. Corequisite, ARCH 411, except by permission of the Dean. Continuation of Design Studio with emphasis on urban design factors. Lecture and studio, 9 hours per week.

ARCH 410 Architectural Science and Technology III. (4) Prerequisites, ARCH 301 and ARCH 311 with a grade of C or better. Corequisite, ARCH 400, except by permission of the Dean. Application of principles in architectural structrues, environmental controls and construction. Lecture and studio, 6 hours per week.

ARCH 411 Architectural Science and Technology IV. (4) Prerequisites, ARCH 400 and ARCH 410 with a grade of C or better. Corequisite, ARCH 401 except by permission of the Dean. Application of principles and further analysis of systems and hardware in architectural structures, environmental controls and construction. Lecture and studio, 6 hours per week.

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.

ARCH 414 Solar Energy Applications for Buildings. (3) Prerequisites, ARCH 311, or ENME 321, or permission of instructor. Methods of utilizing solar energy to provide heating, cooling, hot water, and electricity for buildings and related techniques for reducing energy consumption. Crosslisted as ENME 414.

ARCH 418 Independent Studies in Architectural Science. (1-6) Repeatable to a maximum of six credits. Independent research in architectural science and technology.

ARCH 420 History of American Architecture. (3) Survey history of American architecture from the 17th century to the present. Lecture, 3 hours per week.

ARCH 422 French Architecture 1750-1800. (3) French architectural theory and practice of the second half of the eighteenth century. A reading knowledge of French will be required. Colloquium and independent research. By permission of the instructor.

ARCH 424 History of Russian Architecture. (3) Survey history of Russian architecture from the 10th century to the present. Lecture, 3 hours per week.

ARCH 426 Readings in Contemporary Architecture. (3) Prerequisite, ARCH 326. Readings and analysis or recent architectural criticism. Seminar, three hours per week.

ARCH 428 Selected Topics in Architectural History. (3) Special topics in the history of architecture. Repeatable to a maximum of six credits provided the subject matter is different.

ARCH 429 Directed Studies in Architectural History. (1-3) Enrollment limited to advanced undergraduate and graduate students. Project proposals must receive a recommendation from the curriculum committee of the school of architecture and approval of the Dean of the school prior to registration. Repeatable to a maximum of six credits.

ARCH 430 Problems and Methods of Architectural Preservation. (3) Prerequisite, ARCH 420 or by permission of instructor. Examination of social, cultural, and economic values affecting the theory and practice of architectural preservation in America, with emphasis upon the rationale and methods for the documentation, evaluation, and utilization of existing architectural resources. Field trips.

ARCH 439 Directed Studies in Architectural Preservation. (1-3) Enrollment limited to advanced undergraduates. Projects must receive a recommendation from the curriculum committee of the school of architecture and approval of the Dean of the school prior to registration. Repeatable to a maximum of six credits.

ARCH 447 Advanced Seminar in Photography. (3) Prerequisites, ARCH 340 or APDS 337 or JOUR 351, and consent of instructor. Advanced study of photographic criticism through empirical methods, for students proficient in photographic skills. Photographic assignments, laboratory, seminar, 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.

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.

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, deLeins, Denny, Jamieson, Lynch, Maril, Rearick
Associate Professors: Campbell, DiFederico, Klank, Niese, Pemberton
Assistant Professors: Farquhar, Forbes, Gelman, Green, Schwartz, Withers
Lecturer: Lapinski
Instructor: Reid

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 master of Fine Arts degree will be required to pass an oral comprehensive examination, present an exhibition of his thesis work, write an abstract based on the thesis, and present 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; ARTH 692 / reading knowledge of French *and German; an oral examination and a written* examination; 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 painpainting 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) Seminar 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 1975.

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. (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 514 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 in-

structor. 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 Gericalut—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) thePrerequisite, 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 Hstory. (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 Arts. (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 students. 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, Kundi, Opik, Wentzel, Westerhout
Associate Professors: A'Hearn, Bell, Harrington, Matthews, Rose, Zipoy, Zuckerman
Assistant Professors: Simonson, Trimble (part-time)

The Astronomy Program, administratively 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, celestial 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 addressed 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, ultraviolet, 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 radiotelescopes.

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 radiotelescopes. Observatory work on 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 or 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, Astronomy 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 consituents 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

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. (1-16) Credit according to work done each semester. Prerequisite, consent of instructor. These courses will be given by specialist in various field 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 or 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. (1-16)

ASTR 799 Master's Thesis Research. (1-6)

ASTR 899 Doctoral Dissertation Research. (1-8)

Botany Program

Professor and Chairman: Sisler
Professors: Corbett, Galloway, Kantzes, Klarman, Krusberg, Morgan, Patterson, Stern
Research Professor: Sorokin.
Associate Professors: Bean, Curtis, Karlander Mottos, Rappleye, Reveal
Assitant Professors: Barnett, Blevins, Bottino, Broome Stevenson, Van Valkenburg

'joint appointment with Secondary Education

The Department of Botany offers graduate programs leading to the degrees of Master of Science and Doctor of Philosphy. 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, Plant

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 two-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 405 Teaching Methods in Botany. (2) Four two-hour laboratory demonstration periods per week, for eight 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 407 Teaching Methods in Botany. (2) Four two-hour laboratory demonstration periods per week, for eight 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.

BPTM 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 of basic and economic significance 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) Prerequisite, BOTN 100 or General Biology. Four two-hour laboratory periods a week for eight 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 419 Natural History of Tropical Plants. (2) Prerequisite, one course in plant taxonomy or permission of instructor. An introduction to tropical vascular plants with emphasis on their morphological, anatomical, and habital peculiarities and major taxonomic features, geographic distribution and economic utilization of selected familes. Two one-hour lectures per week.

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 425 Diseases of Ornamentals and Turf. (2) Prerequisite, BOTN 221. Two lectures per week. Designed for those students who need practical experience in recognition and control of ornamentals and turf diseases. The symptoms and current control measures for diseases in these crop areas will be discussed.

BOTN 426 Mycology. (4) Two lectures and two two-hour laboratory periods per week. An introductory study 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 or Maryland crops are discussed. Offered in alternate years or more frequently with demand.

BOTN 441 Plant Physiology. (4) Two lectures and one four-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 structure and composition of natural plant communities, both terrestial and aquatic.

BOTN 463 Ecology of Marsh and Dune Vegetation. (2) Two lectures a week. Prerequisites, BOTN 100. An examination of the biology of higher plants in dune and marsh ecosystems.

BOTN 464 Plant Ecology Laboratory. (2) Prerequisite, BOTN 462 or its equivalent or concurrent enrollment therein. One three-hour laboratory period a week. Two or three field trips per semester. The application of field and experimental methods to the qualitative and quantitative study of vegetation and ecosystems.

BOTN 471 Marine and Estuarine Botany. (3) Prerequisite, BOTN 441 or equivalent. An ecological discussion of plant life in the marine environment of sea coasts, salt marshes, estuaries and open seas.

BOTN 475 Algal Systematics. (4) One lecture and two three-hour laboratory periods per week. Prerequisites, BOTN 100, 202, or permission of instructor. An intensive study of algal structures, morphology, classification and nomenclature including preparation, preservation and identification procedures.

BOTN 477 Marine Plant Biology. (4) Prerequisite, BOTN 100 or General Biology plus Organic Chemistry or the consent of the instructor. Five one-hour lectures and three, 3-hour laboratories each week for six weeks. An introduction to the 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) 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) Second semester. One lecture and two laboratory periods per week. Prerequisites, BOTN 212, BOTN 411, 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) First semester. 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) Fall semester, alternate years. Prerequisites, Biochemistry (CHEM 661) and Cytogentics (BOTN 615) or equivalent, or con-

sent 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) First Semester. 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) First Semester. 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) Second semester. Two lectures per week in 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) Second semester. 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) Second semester. Two lectures and two laboratory periods a week. Prerequisite, BOTN 221 or permission of instructor (not offered 1970-71). 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) First semester. 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) Second semester. Prerequisite, BOTN 641 or CHEM 461 and 462. A treatment of those aspects of biochemistry especially pertinent to plants-respiration, photosynthesis, and organic transformations.

BOTN 644 Plant Biochemistry Laboratory. (2) Plant biochemistry laboratory. Second semester (not offered 1973-74). Prerequisites, 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 three-hour laboratory period per week, plus one one-hour laboratory to be arranged.

BOTN 645 Growth and Development. (2) First semester. 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) Second semester (not offered 1972-73). 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. Second semester (not offered in 1972-73). Prerequisites, BOTN 652 or concurrent registration therein. A quantitative and qualitative study of plant systems by physical and physiochemical methods and instruments. One scheduled three-hour laboratory period per week, plus one-hour laboratory period to be arranged.

BOTN 661 Advanced Plant Ecology. (3) Fall semester (not offered 1973-74). 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) Second semester (not offered 1973-74). Prerequisite, BOTN 642, the equivalent in allies 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. (O) Second semester (not offered 1973-74). 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 semester. 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)

College of Business and Management

Professor and Dean: Lamone
Professors: H. Anderson, Carroll, Dawson, Fisher, Greer, Hille, Levine, Nash, Paine, Taff, Wright
Associate Professors: Ashmen, Courtright, Fromovitz, Gannon, Haslem, Hynes, Kuehl, Leete, Loeb, Olson, Spivey, Thieblot, Widhelm
Assistant Professors: C. Anderson, R. Anderson, Beard, Bedingfield, Bloom, Corwin, Falthzik, Hargrove, Holmberg, Jolson, Lynagh, May, Neuman, Nickels, Pegnetter, Poist, Solomon, Taylor, Testa
Lecturer: Handorf

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.

The College of Business and Management offers an MBA program designed to provide the educational foundation for those students with the potential to exhibit the highest degree of excellence in their future careers as professional managers. Successful students in the program are expected to demonstrate a high level of accomplishment in the following areas:

(1) A thorough and integrated knowledge of the basic tools, concepts, and theories relating to professional management.
(2) Behavioral and analytical skills necessary to deal creatively and effectively with organizational and management problems.
(3) An understanding of the economic, political, technological, and social environments in which organizations operate.
(4) A sense of professional and personal integrity and social responsibility in the conduct of managerial affairs both internal and external to the organization.

The College of Business and Management is the only business school in the Maryland-Washington area accredited by the American Assembly of Collegiate Schools of Business, a reflection of the quality of its faculty, programs, and facilities. Of the more than 500 graduate programs in business and management in the country, only 145 are accredited by the AACSB. In a recent study the College of Business and Management ranked in the top twenty business schools in the areas of administrative science and personnel management, and industrial relations.

Both day and evening courses are staffed by the *full-time* graduate faculty recruited from the graduate programs of the leading universities in the nation, such as Berkeley, Stanford, Northwestern, Harvard, Case Western, Cornell, Wisconsin, Minnesota, Columbia, Johns Hopkins, North Carolina, Purdue, Indiana, Pennsylvania, Penn State, Texas, Ohio State, and Michigan. They are dedicated scholars, teachers, and professional leaders, unusual in their comparative youth, their academic excellence, and their strong committment to providing superior management education.

The students also have access to the exceptional academic and professional resources of the College Park Campus, including excellent library and computer facilities.

If your major undergraduate work has been in areas other than business administration, you will be required to complete a set of basic core knowledge requirements in business and economics with a "B" average before beginning the graduate MBA courses. This knowledge is basic to all managers regardless of organizational setting of field of specialization. The courses required in the core are: principles 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). Course credit by examination is available for some of the above courses. These core courses do not apply toward graduate credit and may be taken as a special undergraduate student. Students whose undergraduate degree is in business administration will ordinarily have included these core courses in their undergraduate work. For the MBA they will need only the 30 hours described below.

A group of four graduate courses (12 hours) is required of all MBA students: BSAD 764, Behavioral Factors in Management; BSAD 734, Introduction to Management Science; BSAD 775, Product, Production, and Pricing Policy; BSAD 740, Financial Administration *or* BSAD 720, Managerial Accounting. This common core provides the student with a knowledge of behavioral and analytical skills as well as a grounding in managerial economics and financial planning and control necessary for all professional managers.

Fields of concentration and electives: The student has a great deal of flexibility in choosing the remaining 6 graduate courses (18 hours). The following fields of concentration are available: (1) organizational behavior, peronnel and labor relations; (2) operations research-statistics; (3) accounting; (4) finance; (5) marketing; (6) transportation. The student does not submit a thesis.

The Doctor of Business Administration (DBA) program is designed for those planning careers in research, service, and university-level teaching as well as 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 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 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 of specialized 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 costs.

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 230 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 231. Surveys anova models, basic and advanced experimental design concepts. Nonparametric tests and correlation 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 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 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 230, 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. Topics covered include the basic theorems of linear programming; the matrix formulation of the simplex, and 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 formulation 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 reading relating to financial decisions of the firm. The application of finance concepts to the 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 Mangement. (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 introduction, 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. (3) 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. Airmail development and services.

BSAD 473 Advanced Transportation Problems. (3) Prequisite, 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 studies 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 or 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 committee. Group meetings of the candidates may be called at the discretion of the faculty advisors/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 they have learned of general management principles and their specialized functional applications to the overall management function in the enterprise.

BSAD 710 Advanced Accounting Theory I. (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 concepts 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. (3) 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 national 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 754 Buyer Behavior Analysis. (3) A systematic examination and evaluation of the literature, research tradition and theory of buyer behavior in the market place from a fundamental and applied perspective. The cognitive and behavioral bases underlying the buying process of individuals and institutions is investigated to better understand, predict, and influence the process through the effective utilization of the firms' marketing resources.

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 Mangement. (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 Behaviorial Science to Business. (3) Prerequisite, BSAD 764 or permission of professor. Stresses case analysis of bahavioral knowledge applied to management problems. Typical topics include analysis of modes of 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. Attention 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 to 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 insitutional 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. (3) 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 technological 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 requriement 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 analyzed 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 in 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 stage 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 administrative 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 divestitures are considered from the viewpoint of profit planning, cash flow, and tax differment.

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 divestitures 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 primal-dual 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 lagrangena, the concept of an algorithm (notation map convergence), unconstrained problems, convex simplex and method of centers algorithms, penalty and barrier, feasible-directions and cutting plan algorithms.

BSAD 833 Management Science IV—Integer and Dynamic Programming. (3) Prerequisite, Business—BSAD 831 and BSAD 832 or consent of instructor. Mathematics—MATH 241 minimum, MATH 400 and 410 preferred. Coverage includes fractional, all integer and mixed integer algorithms, the knapsack problem, decomposition, recusion 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 recommended. 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 queuing 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, verification 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 explain 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, Bolsaitis, Cadman, Duffey, Goldman, Johnson, Marchello, Munno, Regan, Schroeder, Silverman, Skolnick, Smith, Spain
Associate Professors: Almenas, Gentry, Kugelman, Sheaks
Assistant Professors: Blair, Gasner, Hatch
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 chairman. 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) Prerequisite, 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 commerical 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 commerical 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 485 Biochemical Engineering Laboratory. (2) Prerequisite or co-requisite, ENCH 482. Techniques of measuring pertinent parameters in fermentation reactors, quantification of production variables for primary and secondary metabolites such as enzymes and antibiotics, the insolublization of enzymes for reactors, and the demonstration of separation techniques such as ultrafiltration and affinity chromatography.

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 equalibria 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, thermal properties of polymers. Measurement of moleculer 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) First semester. 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) First semester, 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) First semester. 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) Second semester. 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. (1-16)

ENCH 655 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 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, electro-

nuclear 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; isotope 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) Second Semester. Prerequisite, ENCH 630. Development of mathematical 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) First and second semesters. 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) Second semester. The theory and application of complex equilibrium stages. Binary and multicomponent absorption; extraction; liquefaction.

ENCH 735 Chemical Process Dynamics. (3) First semester. 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) Second semester. 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 Enzyme Engineering. (3) Prerequisite, ENCH 640 Enzyme science and kinetics; principles of enzyme insolublization and denaturation with application to design, operation and modeling of enzyme reactors. The relationship between mass transfer and apparent kinetics in enzyme systems; and techniques of separation and purification of enzymes.

ENCH 762 Advanced Biochemical Engineering. (3) Prerequisite, ENCH 482 or permission of instructor Advanced topics to include use of a digital computer for mathematical modeling of the dynamics of biological systems; separation techniques for heat sensitive biologically active materials; and transport phenomena in biological 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; artificial kidney; heart assistor; membrane oxygenator; materials problems, physiological considerations.

ENCH 784 Polymer Physics. (3) Prerequisite, ENCH 490 or consent of instructor. Application and corelation 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. (3) Second semester. Prerequisite, CHEM 604.

ENCH 828 Advanced Topics in Chemical Reaction Systems. (3) First semester. Offered in alternate years. Prerequisite, ENCH 640.

ENCH 838 Advanced Topics in Transfer Theory. (3) First semester. Offered in alternate years. Prerequisite, ENCH 720.

ENCH 848 Advanced Topics in Separation Processes. (3) Second semester. Offered in alternate years.

ENCH 899 Doctoral Dissertation Research. (1-8)

Chemistry Program

Professor and Chairman: Vanderslice
Professors: Adler, Breger, Castellan, Freeman, Goldsby, Gordon, Grim, Henery-Logan, Holmlund, Jaquith, Keeney,[1] Munn, Pickard, Ponnomperuma, Pratt, Purdy, Reeve, Rollinson, Rose, Staley, Stewart, Stuntz, Veitch, Viola
Associate Professors: Ammon, Bellama, Boyd, Davis, DeVoe, Huheey, Jarvis, Kasler, Khanna, Lakshmanan, Martin, Mazzocchi, Miller, Moore, O'Haver, Sampugna, Sommer, Walters, Zoller
Assistant Professors: Alexander, Gergeron, Campagnoni, Hansen, Heikkiaen, Helz, Murphy, Olin, Tossell
Research Professor: Bailey
Lecturer: Chaiken

[1]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.

Both the thesis and non-thesis options are offered for the M.S. degree. Departmental regulations concerning qualifying (diagnostic) examinations, comprehensive examinations, and other matters pertaining to course work 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 a "clean" room for lunar sample analysis, X-ray fluorescence instrumentation, an electron microprobe, mass spectrometers, NMR spectrometers including a 100 MHz, Fourier-transform NMR spectrometer, 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; interactions 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 three-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 three-hour laboratory periods per week. Corequisite, CHEM 481. An introduction to the principles and applications of quantitative techniques useful 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 three-hour laboratory periods per week. Prerequisite, CHEM 481; corequisite, CHEM 482. An intro-

duction 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 three-hour laboratory periods per week. Prerequisite: CHEM 201-202 or 211-212, and 203-204 or 213-214

CHEM 441 Advanced Organic Chemistry. (3) Prerequisite, CHEM 481. An advanced study of the compounds of carbon, with special emphasis on molecular orbital theory and orbanic reaction mechanisms.

CHEM 443 Qualitative Organic Analysis. (3) One lecture and two-three hour laboratory periods per week. Prerequisite: CHEM 201-202 or 211-212, and 203-204 or 213-214 The systematic identification of organic compounds.

CHEM 447 Geochemistry of Fuels. (3) Prerequisite, CHEM 104 or consent of instructor Discussion of the progenitors and the biochemical, chemical and physical agencies that convert them into crude oils, coals of various ranks, natural gas, and other organic fuels. The origin, composition, mineralogy, and organic constituents (kerogen) of oil shales. Mineralogy, geochemical cycles, and accumulation of uranium and thorium.

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 three-hour laboratory periods per week. Prerequisite, CHEM 461. or concurrent registration in CHEM 461.

CHEM 464 Biochemistry Laboratory II. (2) Two three-hour laboratory periods per week. Prerequisite, CHEM 462 or concurrent registration in CHEM 462, and CHEM 430 or CHEM 463.

CHEM 471 Geochemical Methods of Analysis. (3) Prerequisite, CHEM 103, 104 The course will consider the principles and application of geochemical analysis as applied to a variety of geological problems. The topics covered will include x-ray and optical spectroscopy, x-ray diffraction, atomic absorption, electron microprobe and electron microscopy

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 General 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 three-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 three-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 three-hour laboratory periods per week.

CHEM 604 Advanced Inorganic Laboratory. (2) Two three-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 three 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 three 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 three-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 fluorescense, nephelometry, and of certain closely related subjects like NMR and mass spectroscopy.

CHEM 624 Electrical Methods of Quantitative Analysis. (3) Two lectures and one three-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 three-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 three-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 678 Special Topics in Environmental Chemistry. (3) Prerequisite—CHEMISTRY 474. In-depth treatment of environmental chemistry problem areas of current research interest. The topics will vary somewhat from year to year. Repeatable to maximum of 6 credits. Provided subject is different.

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 699 Special Problems in Chemistry. (3) Prerequisite—one semester of graduate study in chemistry. Laboratory experience in a research environment. Restricted to students in the non-thesis M.S. option. Repeatable for a maximum of 6 credits.

CHEM 702 Radiochemistry Laboratory. (1-2) One or two four-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 CHEM 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 four-hour laboratory periods per week. Prerequisite, 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 727 Geochemical Differentiation. (3) Distribution of the chemical elements in the earth and the mechanisms by which the distributions came about.

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 750 Chemical Evolution. (3)- Prerequisite, CHEM 441, or 721; or ZOOL 446; or BOTN 616; or consent of instructor. The chemical processes leading to the appearances of life on earth. Theoretical and experimental considerations related to the geochemical, organic, and biochemical phenomena of chemical evolution.

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
Lepper, Otts, Ragan, Sternberg
Associate Professors: Birkner, Colville, Cookson, Cournyn, Garber, Hall, Heins, Israel, McCven, Piper,[1] Wedding, Witczak
Assistant Professors: Albrecht, Loutzenheiser, Mulinazzi, Yoo

[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. All programs are planned on an individual basis by the student and his advisor to consider the student's background and special interests. Courses and research opportunities are available in the general areas of transportation and urban systems, environmental engineering and water resources, structural engineering, and soil mechanics. In general, emphasis is on learning sound engineering principals and applying them to the solution of the problems of man in his environment.

Applicants for admission should hold a B.S. degree in Civil Engineering. However, applicants with undergraduate degrees in other disciplines have been accepted with the stipulation that deficiencies in prerequisite undergraduate course work be corrected before enrolling in graduate courses. There are no entrance examinations required to enter the program.

Two options are available for the Master of Science degree: thesis and non-thesis. The thesis option requires 24 credit hours plus a thesis, while the non-thesis option is 30 credit hours of course work. The department s policies are the same as the requirements of the Graduate School.

The requirements for the Doctor of Philosophy degree are the same as those imposed by the Graduate School. An individual program of study to suit the needs of the student is developed by the student and his advisor. The equivalent of two years of full-time study beyond the Master of Science degree is the minimum requirement. The student must pass a qualifying examination before being admitted to candidacy. Normally, the qualifying exam is taken one year after the completion of the M.S. degree. No language requirement exists for the Ph.D. degree.

Almost all full-time graduate students receive financial assistance which, as a minimum, includes tuition remission plus $290. per month for master students.

The research facilities of the department are available to graduate students. These include laboratories in the following areas; transportation, systems analysis, environmental, hydraulics, structures, and soil mechanics. A UNIVAC 1106 and a UNIVAC 1108, complemented by remote access units located in the engineering building, are available.

The Washington and Baltimore Metropolitan Areas are easily accessible for data, field studies, library access, contacts with national organizations and attendance at national meetings. The location of the University of Maryland offers a unique opportunity to obtain an advanced degree in Civil Engineering.

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 gauges, photoelasticity, brittle laquer methods and various analogies.

ENCE 420 Basic Civil Engineering Planning I. (3) Prerequisites, senior standing or consent of the instructor. Urban-regional physical planning from the civil engineering viewpoint. Integration of the planning aspects of engineering—environmental, structural, transportation and water resources—into a systems approach to the practice of civil engineering. Also included: site, construction, and engineering materials planning; engineering economics and evaluation; current topics.

ENCE 430 Intermediate Fluid Mechanics. (4) Three lectures and one laboratory per week. Prerequisite, ENCE 330. Application of basic principles to the solution of engineering problems: ideal fluid flow, mechanics of fluid resistance, open channel flow under uniform, gradually varied and rapidly varied conditions, sediment transport, role of model studies in analysis and design.

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. Hydrometology, 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 Health 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 and ENCE 330. The application of sanitary analysis and fundamental principles to the design and operation of water and waste water 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 essential 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 Design of Steel Structures. (3) Prerequisites, ENCE 350 and concurrent registration in ENCE 351. Analyses for stresses and deflections in structures by methods of consistent deformations, virtual work and internal strain energy. Application to design of plate girders, indeterminate and continuous trusses, two hinged arches and other structures. Elements of plastic analysis and design of steel structures.

ENCE 451 Design of Concrete Structures. (4) Prerequisites, ENCE 340 and ENCE 351. Three lecture hours and one laboratory per week. Design of reinforced concrete structures, including slabs, footings, composite members, building frames, and retaining walls. Approximate methods of analysis; code requirements; influence of concrete properties on strength and deflection; optimum design. Introduction to prestressed concrete design.

ENCE 460 Modern Techniques for Structural Analysis. (3) Prerequisites, ENCE 351, and ENCE 360. Two lecture hours and one laboratory per week. Application of computer oriented methods and numerical techniques to analysis and design of structural systems. Matrix formulation of the stiffness and flexibility methods for framed structures. Introduction of numerical techniques to the solution of selected problems in such topics as plates, structural stability, and vibrations.

ENCE 461 Analysis of Civil Engineering Systems I. (3) Prerequisite, senior standing or consent of instructor. Application of the principles of engineering economy and statistics to the solution of civil engineering problems. Economic comparison of alternatives using present worth, annual cost, rate of return and cost, rate of return and cost benefit analyses. Development and use of simple and multiple regression models, and statistical decision theory.

ENCE 470 Highway Engineering. (4) Three lectures and one three-hour laboratory 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 and 370 Two lectures and one laboratory per week Principles of pavement analysis and design. Analysis of moving loads and pavement response. Subgrade evaluation and beneficiation. 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 students for study in a particular field of civil engineering.

ENCE 600 Advanced Engineering Materials Laboratory. (3) Prerequisites, ENES 220, 221 and ENCE 300 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) Prerequisite, ENCE 450 and ENCE 451 or equivalent. Instrumentation, data analysis; states of stress; structural models, structural similitude; analogies; nondestructive testing techniques; planning research projects, lab studies and reports.

ENCE 620 Urban-Regional Civil Engineering Planning. (3) First semester. 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) Second semester. Prerequisite, ENCE 620 or

equivalent. General to comprehensive planning or 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 characteristics of natural water systems. 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 Health Engineering. (3) Prerequisite, ENCE 221 or consent of instructor. Properties and quality criteria of drinking water as related to health are interpretated 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 Health 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 aerobic and anerobic 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 resistance, 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 non-linearity, automated and optimum design non-prismatic 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 effecting 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 ENCE 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 the 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 parking 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 modes. Transportation planning studies, statewide traffic models, investment models, programming and scheduling.

ENCE 673 Urban Transportation. (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 socio-economic 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 nonlinear 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 Language and Literature Courses

Greek

GREK 400 Level course prerequisite, 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

LATN 400 Level course prerequisite, 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 selections from the Peregrinatio Ad Loca Sancta and the study of divergences from classical usage therein, with special emphasis of those which anticipate subsequent developments in the romance languages. Reports.

Comparative Literature Program

Professor and Chairman: Kenny
Assistant Professor and Executive Secretary: Swigger
Professors: Freedman, Goodwyn, Jones, Perloff, Panichas, Salamanca
Associate Professors: Coogan, Greenwood
Assistant Professor: Lebreton-Savigny

The Program in Comparative Literature offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

The CMLT Program emphasizes work in medieval, Renaissance, Romantic, and modern literature, in the standard European languages. The focus of courses and seminars tends to be specifically literary, but interdisciplinary work is by no means precluded.

Applicants should have a strong background in literary and humanistic studies. Since advanced work in Comparative Literature is based on the premise that literature should be read in the original whenever possible, students are expected to be able to read at least one language other than English (preferably French, German, or Spanish), with a high degree of aesthetic appreciation. Ph.D. students are expected to use at least two foreign languages actively in their work, and it is assumed that they will have or develop an acquaintance with one or two additional languages. Entrance examinations are not required, but high scores

on GRE literature and language examinations will add weight to applications.

Financial aid about one fourth of CMLT graduate students receive financial aid. Ordinarily applicants compete for assistantships in the Freshman English program. In exceptional cases, applicants have been able to obtain positions in foreign language departments.

Students take courses in CMLT and two other departments of literature. The M.A. degree requires thirty hours, either 24 hours of course work and a thesis, or thirty hours of course work and a comprehensive examination. No specific number of hours is required for the Ph.D., as the number will vary according to the preparation and goals of the individual student; the average has been eight courses beyond the M.A. A Master's degree is a required step toward the Ph.D. The Ph.D. comprehensive examinations cover three major areas, determined tin consultation with the graduate advisers.

Departments cooperating in the Program: English, French and Italian, German and Russian, Spanish and Portuguese, Classics.

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.

CMLT 402 Introductory Survey of Comparative Literature. (3) Study of the medieval and modern continental literature.

CMLT 411 The Greek Drama. (3) The Chief works of Aeschylus, Sophocles, Euripedes, 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.

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.

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.

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.

CMLT 430 Literature of the Middle Ages. (3) Narrative, dramatic and lyric literature of the Middle Ages studied in translation.

CMLT 433 Dante and the Romance Tradition. (3) A reading of the Divine Comedy to enlighten the discovery of reality in western literature.

CMLT 461 Romanticism—Early Stages. (3) Emphasis on England, France and Germany. Reading knowledge of French or German required

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.

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.

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.

CMLT 498 Selected Topics in Comparative Literature. (3)

CMLT 601 Problems in Comparative Literature. (3)

CMLT 610 Folklore in Literature. (3)

CMLT 631 The Medieval Epic. (3)

CMLT 632 The Medieval Romance. (3)

CMLT 639 Studies in the Renaissance. (3) Repeatable to a maximum of nine hours.

CMLT 640 The Italian Renaissance and its Influence. (3)

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.

CMLT 679 Seminar in Modern and Contemporary Literature. (3) Seminar in modern and contemporary literature. As announced. Repeatable to a maximum of 9 hours.

CMLT 681 Literary Criticism—Ancient and Medieval. (3)

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 Acting Chairman: Atchison
Professors: Chu[2], Edmundson[3], Glasser[4], Kanal, Minker
Associate Professors: Austing, Stewart[6], Vandergraft
Assistant Professors: Agrawala, Basili, Feldman, Hagerty[1], Hamlet, Hecht, Lay, McClellan, Mills, Noonan, Rieger, Zelkowitz
Research Professors: Rheinboldt[1,3], Rosenfield[1]

[1]Joint appointment with Computer Science Center
[2]Joint appointment with Electrical Engineering
[3]Joint appointment with Mathematics
[4]Joint appointment with Physics
[5]Joint appointment with College of Library and Information Services
[6]Joint appointment with Institute for Fluid Dynamics and Applied Mathematics

The Department of Computer Science 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 Departmental Education Office. 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.

The Department maintains a PDP 11/45 computer system and utilizes the UNIVAC 1108/1106 computer system maintained by the Computer Science Center.

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. Micro-operations. Sequences. Computer simulation. Organization of a commercially available stored program computer. Microprogrammed computers. A large-scale batch-processing system.

CMSC 415 Systems Programming. (3) Prerequisites, CMSC 220, 410. Basic algorithms of operating system software. Memory management using linkage editors and loaders, dynamic relocation with base registers, paging.

File systems and input/output control. Processor allocation for multiprogramming, timesharing. The emphasis of the course is on practical systems programming, including projects such as a simple linkage editor, a stand-alone executive, a file system, etc.

CMSC 420 Data Structures. (3) Prerequisite, CMSA 220 or equivalent. Description, properties, and storage allocation of data structures including lists and trees. Algorithms for manipulating structures. Applications from areas such as data processing, information retrieval, symbol manipulation, and operating systems.

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 of constituents, subroutines, coroutines, tasks and parameters. List processing and data description languages.

CMSC 445 Compiler Writing. (3) Prerequisites, CMSC 220, 440. A detailed examination of a compiler for an algebraic language designed around the writing of a compiler as the major part of the course. Topics covered in the course include a review of scanning and parsing, the examination of code generation, optimization and error recovery, and compiler-writing techniques such as bootstrapping and translator writing systems.

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 452 Elementary Theory of Computation. (3) Prerequisites, CMSC 120, 250. This course is intended to serve two purposes: (1) an introduction to the theory of computation, and (2) a tie between many abstract results and their concrete counterparts. This course establishes a theoretical foundation for the proper understanding of the inherent limitations and actual power of digital computers. Also, it provides a relatively uniform way of stating and investigating problems that arise in connection with the computation of particular functions and certain classes of functions. Topics covered include an introductory treatment of classes of computable functions, computability of register machines, computability by turing machines, unsolvable decision problems, concrete computational complexity, and complexity of loop programs.

CMSC 455 Elementary Formal Language Theory. (3) Prerequisites CMSC 120, 250. This course is intended to serve as an introduction to the theory of formal languages. This theory is encountered in the study of both programming languages and natural languages, and consequently will be useful in numerous other courses in computer science at the undergraduate and graduate levels. Topics covered include the highlights of Chomsky's hierarchy of grammars and Chomsky's hierarchy of languages, a summary treatment of acceptors related to these languages, and a brief introduction to the theory of transformational grammars.

CMSC 460 Computational Methods. (3) Prerequisite, MATH 241 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. (Credit will be given for only one course, MATH/CMSC 470 or MATH/CMSC 460.)

CMSC 470 Introduction to Numerical Analysis. (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 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 480 Simulation of Continuous Systems. (3) Prerequisite, CMSC 280 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 systems, 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 precessors. 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 of 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, VanWijngaarden 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 638).

CMSC 700 Translation of Programming Languages. (3) Prerequisites, CMSC 420 and 441. Application of theoretical concepts developed in formal language and automata theory to the analytic design of programming languages and their processors. Theory of push-down automata, precedence analysis, and bounded-context syntactic analysis as models of syntactic portion of translator design. Design

criteria underlying compiler techniques, such as backtracking and lookahead. 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, marco 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 computional techniques to linguistics and natural-language processing. Research cycle of corpus selection, pre-editing, keypunching, processing, post-editing, and evaluation. General-purpose input Processing, and output routines. Special-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 depthhypothesis and syntactic complexity. Markov-chain models of word and sentence generation, Shannon's information theory, Carnap and Bar-Hillel's semantic theory, lexicostatistics 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 search 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, "O," 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 language, 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. Push-down automata. Linear-bounded automata. Finite transducers. Turing machines; 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 opertions. Undecidability theorems.

CMSC 750 Theory of Computability. (3) Prerequisite, CMSC 640. Algorithms; Church's thesis. Primitive recursive functions; Godel numbering. General and partial recursive functions. Turing machines; Turings' thesis. Markov algorithms. Church's lamda calculus. Grzegorczyk hierarch; 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, Kullback 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 441. 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) Prerequisite, CMSC 21, 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.

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)

Cooperative Education Engineering Courses

ENCO 408 Co-op Internship. (0) Professional internship in industry or government agency provides the practical work experiences which supplement and enhance the theories, principles and practices in the normal educational program. The student should register for ENCO 408 for each summer internship. He should register for both ENCO 408 and ENCO 409 for each semester internship.

ENCO 409 Co-op Internship. (0) Professional internship in industry or government agency provides the practical work experiences which supplement and enhance the theories, principles and practices studied in the normal educational program. The student should register for ENCO 408 for each summer internship. He should register for both ENCO 408 and 409 for each summer internship.

Counseling and Personnel Services Program

Professor and Chairman: Marx
Professors: Byrne, Hoyt, Magoon,[1] [2] Pumroy,[1]
Associate Professors: Allan, Birk,[2] Greenberg, Lawrence, Martin, Medvene,[2] Ray, Rhoads, Stern
Assistant Professors: Brooks, Carlson, Chasnoff, Colby, Gump, Hardwick, Kafka, Knetelkamp, Krieger, Leonard Levine, Magrab, McMullan, Spielbichler, Westbrock[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 Development, 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 empirical 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) The nature and property of groups, interaction analysis, developmental phases, leadership dynamics and styles, roles of members and interpersonal communications. Two hours of lecture-discussion and two hours of laboratory per week; laboratory involves experimental based learning.

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 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 EDCP 489, 888, and 889 is limited to a maximum of 20 semester hours.

EDCP 498 Special Problems in Counseling and Personnel Services. (1-3) Prerequisite, consent of instructor. Available only to major students who have formal plans for individual study of approved problems.

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 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 Personnel Services. (3) Examination 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 nonstandardized pupil appraisal data; synthesis of all types of data through case study procedures.

EDCP 616 Counseling—Theoretical 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, 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, 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, practicum experience.

EDCP 634 Diagnostic Appraisal of Children II. (4) Prerequisite, EDCP 633. Assessment of development, emotional, and learning problems of adolescents in schools. Practicum experience.

EDCP 635 Therapeutic Techniques and Classroom Management. (3) Prerequisite, EDCP 414. Diagnosis and treatment of problems presented by teachers and parents. Practicum experience.

EDCP 636 Therapeutic Techniques 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 communications 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. (1-6) Prerequisite, permission of the instructor. Repeatable to a maximum of six hours.

EDCP 718 Advanced Seminar in Group Processes. (2-6) Prerequisites, EDCP 626. Repeatable to a maximum of six 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. Previous practicum experience. Individual supervision of counseling, and group consultation. Repeatable to a maximum of six credits.

EDCP 789 Advanced Topics in Counseling and Personnel Services. (1-6) Repeatable to a maximum of 6 credits.

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 advisers may register for credit under this number.

EDCP 799 Master's Thesis Research. (1-6) Registration required to the extent of six hours 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 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 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) 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 EDCP 489, 888 is limited to a maximum of twenty (20) semester hours.

EDCP 899 Doctoral Dissertation Research. (1-16) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Criminal Justice and Criminology Program

Professor and Director: Lejins
Associate Professors: Maida, Tennyson, Wheeler
Assistant Professors: Ingraham, Johnson

The Program of graduate study leading to a Master of Arts and Ph.D. degree in the area of Criminal Justice and Criminology is intended to prepare students for research, teaching and professional employment in the operational agencies in the field of criminal justice. This program combines an intensive background in a social science discipline such as sociology, psychology, public administration, etc., with graduate-level study of selected aspects of the criminal justice field.

Students enrolled in the M.A. program have two options: a Criminology option and a Criminal Justice option. The general plan of study for both options is as follows:

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,
   b. an M.A. degree without thesis, but with some additional requirements.

In addition to the general Graduate School requirements, 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 program.

Admission to the Ph.D. program in Criminal Justice and Criminology depends on meeting the general Graduate School requirements and is determined by the Graduate Admissions Committee of the Institute. Admission presupposes completion of the M.A. degree. For completion of the Ph.D. degree, in addition to the general Graduate School Ph.D. requirements, competence in the theory of at least one social science discipline, in research methodology and in quantitative techniques is expected, as well as competence in the general theory of the criminal justice field and in the specialization area selected by the student. The necessary coursework is determined on the basis of the student's previous preparation, needs, and interests. The candidate is required to pass Ph.D. comprehensive examinations, acquire at least 12 hours of Ph.D. research credits, and prepare and defend a doctoral dissertation under the guidance of his Ph.D. dissertation committee.

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 or release on parole. Probation, punishments, special treatments for special offenders, parole and pardon, and the 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.

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.

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.

CRIM 454 Contemporary Criminological Theory. (3) Prerequisite, CRIM 220, CRIM 450, and CRIM 451 or CRIM 452 or CRIM 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. (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) First semester. Survey of the principal issues in contemporary criminological theory and research.

CRIM 651 Seminar in Criminology. (3) Second semester.

CRIM 652 Seminar in Juvenile Delinquency. (3) First Semester

CRIM 653 Crime and Delinquency as a Community Problem. (3) Second semester. 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. (3)

CRIM 899 Doctoral Dissertation Research. (1-8) Doctoral dissertation research in criminal justice and criminology.

Institute of Criminal Justice and Criminology

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 462 Special Problems in Security Administration. (3) Prerequisites, LENF 360 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 to be announced in the field of criminal justice. Repeatable to a maximum of six credits.

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 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, one course in the theory of groups or organizations, 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. Repeatable to a maximum of 6 credits

LENF 799 Master's Thesis Research. (1-6)

Dairy Science Program

Professor and Acting Chairman: Mattick
Professors: Cairns, Bull, Davis, King, Vandersall, Williams
Associate Professor: Douglass
Assistant Professors: Westhoff

The Department of Dairy Science offers programs leading to the degrees of Master of Science and Doctor of Philosophy. Candidates for degrees have the option of studying in one of two major areas: dairy production which is concerned with the management, breeding, nutrition and physiology of dairy animals; or dairy technology which is concerned with the chemical, microbiological and nutritional aspects of dairy products, as well as the industrial phases of milk products processing. Dairy Science faculty are active participants in the interdepartmental graduate programs in Animal Science, Food Science and Nutritional Sciences. Through such participation, Dairy Science graduate students are provided a wide range of options for graduate program development. Both thesis and non thesis Master of Science options are offered.

The Department has two dairy herds that are utilized in its research programs. One is located on the College Park Campus and the other approximately 30 miles from campus at the Dairy and Agronomy Forage Research Farm. A dairy processing facility is also available for dairy products research. In addition, the Department participates in a cooperative research agreement with the USDA Research Center that is located at Beltsville, Maryland. This agreement enables students to work with dairy animals in cooperative research with departmental faculty as well as research personnel at this federal facility.

Financial assistance is available for graduate students on a basis of need, previous academic performance and research and teaching requirements of the Department. Sources of funds are departmental assistantships and research grants. Approximately 50 percent of the graduate students receive financial assistance.

A.B.S. degree in dairy science is not required; however, applicants must have a strong background in the biological sciences. Students without such background will be required to take course work to eliminate appropriate deficiencies. Normally on a full time basis, the time required for completion of the Master of Science degree is 2 years. The Doctor of Philosophy usually requires a minimum of an additional 3 years. On recommendation of the Departmental Graduate Program Advisory Committee, a student may proceed in a program that leads directly to the Doctor of Philosophy degree. There is no language requirement in the program.

A Doctor of Philosophy applicant must successfully pass a departmental comprehensive examination prior to advancement to candidacy. This examination

is taken at least two semesters prior to the completion of all degree requirements. In the final examination, the candidate must successfully defend a research thesis.

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 458 Group Forms. (3) Prerequisite, DANC 400 or equivalent. Choreography for small groups; duets, trios, quartets, etc.

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 choreography 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 388 or equivalent and an adequate understanding of dance techniques. Advanced 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.

DNAC 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 488 Practicum in Dance. (1-6) Advanced workshop in dance presentation including performing, production, and planned field experiences. Repeatable to a maximum of six credits.

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 or permission. 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: Sublette
Professors: Ashlock, Duffey, Goff, Leeper, O'Neill, Weaver, J. Wilson, R. Wilson
Associate Professors: Amershek, Church, Dietz, Eley, Gantt, Heidelbach, Herman, Roderick, Sullivan, Williams
Assistant Professors: Hutchings, Jantz, Johnson, McCuaig, Paserba, Schumacher, Seefeldt, Sunal

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.

Masters Degree programs average 30-36 semester hours. Ph.D. programs average 90 semester hours, including work at the master's level. All applicants must submit the Miller Analogy Test score as prerequisite to admission.

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 Science Teaching Center, the Teacher Education Centers in local schools, 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.

The department is able to give financial aid, in the form of graduate assistantships, to students of proven ability who have had public school teaching experience.

There is a comprehensive examination near the completion of work at the master's level. The Ph.D. program includes a preliminary examination after approximately 12 semester hours of work and a comprehensive examination near the completion of the program.

EDEL 401 Science in Early Childhood Education. (3) Designed primarily to help in-service teachers, nursery school through grade 3, to 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 nursery school through grade 3. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 402 Science in the Elementary School. (3) Designed primarily to help in-service teachers, grades 1-6, to 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 grades 1-5. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 404 Language Arts in Early Childhood Education. (3) Teaching of spelling, handwriting, oral and written expression and creative expression. Designed primarily for in-service teachers, nursery school through grade 3. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily, there is no field placement.

EDEL 405 Language Arts in the Elementary School. (3) Teaching of spelling, handwriting, oral and written expression and creative expression. Designed primarily for in-service teachers, grades 1-6. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 406 Social Studies in Early Childhood Education. (3) Consideration given to curriculum, organization and methods of teaching, evaluation of newer materials and utilization of environmental resources. Designed for in-service teachers, nursery school through grade 3. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

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. Designed for in-service teachers, grades 1-6. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 410 The Child and the Curriculum—Early Childhood. (3) Relationship of the school curriculum, nursery school through grade 3, to child growth and development. Recent trends in curriculum organization; the effect of environment on learning; readiness to learn; and adapting curriculum content and methods to maturity levels of children. Designed for in-service teachers, nursery school through grade 3. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 411 The Child and the Curriculum—Elementary. (3) Relationship of the school curriculum, grades 1-6, to child growth and development. Recent trends in curriculum organization/ the effect of environment on learning; readiness to learn; and adapting curriculum content and methods to maturity

levels of children. Designed for in-service teachers, grades 1-5. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

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) Prerequisite, MATH 210 or equivalent. Emphasis on materials and procedures which help pupils sense arithmetic meanings and relationships. Designed to help in-service teachers, nursery school through grade 3, gain a better understanding of the number system and arithmetical processes, offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 414 Mathematics in the Elementary School. (3) Prerequisiste, MATH 210 or equivalent. Emphasis on materials and procedures which help pupils sense arithmetic meanings and relationships. Designed to help in-service teachers, grades 1-6, gain a better understanding of the number system and arithmetical processes. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily there is no field placement.

EDEL 415 Diagnosis and Treatment of Learning Disabilities in Mathematics. (3) Prerequisite, EDEL 314 or equivalent and approval of instructor. Diagnosis and treatment of disabilities in mathematics, techniques and materials useful for working with children in both clinical and classroom settings. Case studies with children previously diagnosed as primarily corrective rather than severely disabled. Laboratory hours to be arranged.

EDEL 424 Literature for Children and Young People, Advanced. (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 reading readiness, use of experience stories, 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. Designed for in-service teachers, nursery school through grade 3. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily, there is no field placement.

EDEL 426 The Teaching of Reading—Elementary. (3) Concerned with the fundamentals of developmental reading instruction, including reading readiness, use of experience stories, 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. Designed for in-service teachers, grades 1-6. Offered during summer sessions and in off-campus programs taught through University College. Ordinarily, there is no field placement.

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 488 Special Topics in Elementary Education. (1-3) Prerequisite, consent of instructor. Special treatment of current topics and issues in elementary education. Repeatable to maximum of 6 credits, provided content is different.

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 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 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, 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 Elementary School Mathematics Curricula. (3) Prerequisite, EDEL 314 or equivalent and approval of instructor. Critical evaluation of past and present curricular projects, experimental programs, and instructional materials. Design and implementation of elementary school mathematics curricula.

EDEL 615 Diagnosis and Treatment of Learning Disabilities in Mathematics. (3) Prerequisite, EDEL 415 or equivalent and approval of instructor. Diagnosis and treatment of severe learning disabilities in elementary school mathematics. Theoretical models, relevant research and specific techniques appropriate for accessing the interaction of subject matter, organismic, and instructional variables will be developed. Laboratory hours for case study work to be arranged.

EDEL 618 Practicum in Diagnosis and Treatment of Learning Disabilities in Mathematics. (3) Prerequisite, EDEL 615 or equivalent and approval of instructor. Case studies under supervision with children experiencing learning difficulties in mathematics. Diagnostic treatment, and reporting procedures developed in EDEL 415 and 615 are extended. Course may be repeated to a maximum of 6 hours.

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 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 problem 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 719 Research Seminar in Teaching and Learning of Elementary School Mathematics. (3) Prerequisite, EDMS 446 and EDEL 614 or equivalents. Critical evaluation of past and current research, formulation of researchable questions, design and conduct of research in the teaching and learning of elementary school mathematics. Course may be repeated to a maximum of 6 hours

EDEL 788 Special Topics in Elementary Education. (1-3) Prequisite, consent of instructor. Special and intensive treatment of current topics and issues in elementary education Repeatable to maximum of 6 credits

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 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.

EDEL 799 Master's Thesis Research. (1-6) Registration required to the extent of six hours 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. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Economics Program

Professor and Chairman: Dillard
Professors: Adelman, Almon, Bergmann, Cumberland, Gruchy, Harris, Kelegian, McGuire, O'Connell, Olson, Schultze, Ulmer, Wonnacott
Associate Professors: Aaron, Adams, Bennett, Betancart, Clague, Dodge, Dorsey, Knight, Meyer, Singer, Straszheim, Weinstein
Assistant Professors: Christensen, Clotfelter, King, Layher, Lieberman, MacRae, Madan, Morton, Peterson, Schiller
Lecturers: Hinrichs, Measday, Pierce, Qualls

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. In addition, the Aptitude Test section of the Graduate Record Examination is required, and 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. While part-time graduate study certainly is possible, few courses are taught at night.

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 201, 203. Required for economics majors. Analysis of the determination of national income, employment, and price levels. Discussion of consumption, investment, inflation, and government fiscal and monetary policy.

ECON 402 Business Cycles. (3) First semester 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.

ECON 403 Intermediate Price Theory. (3) Prerequisite—ECON 201, 203. Required for economics majors. An analysis of the theories of consumer behavior and of the firm, and of general price and distribution theory, with applications to current economic issues.

ECON 407 Contemporary Economic Thought. (3) Prerequisites—ECON 201, 203, and sen-

ior standing. Graduate students should take ECON 705. A survey of the development of economic thought since 1900 with special reference to Thorstein Veblin and other pre-1939 institutionalists and to post-1945 neo-institutionalists such as J.K. Galbraith and Gunnar Myrdal.

ECON 411 American Economic Development. (3) Prerequisites—ECON 201, 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.

ECON 415 Introduction to Economic Development of Underdeveloped Areas. (3) Prerequisite, ECON 201, 203, or 205. An analysis of the economic and social characteristics of underdeveloped areas. Recent theories of economic development, obstacles to development, policies and planning for development.

ECON 418 Economic Development of Selected Areas. (3) 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 Economic Statistics. (3) Prerequisite MATH 110 or equivalent. Not open to students who have taken BSAD 230 or BSAD 231. An introduction to the use of statistics in economics. Topics include: probability, random variables and their distributions, sampling theory, estimation, hypothesis testing, analysis of variance, regression analysis, correlation.

ECON 422 Quantitative Methods in Economics. (3) Prerequisites: ECON 201, 203, 421 (or BSAD 230), or permission of instructor. Emphasizes the interaction between the economic problems posed by economists and the assumptions employed in statistical theory. Deals with the formulation, estimation and testing of economic models. Topics include single variable and multiple variable regression techniques, theory of identification, autocorrelation and simultaneous equations. Independent work relating the material in the course to an economic problem chosen by the student is required.

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.

ECON 430 Money and Banking. (3) Prerequisite, ECON 201, 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 Economic 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 macrosystems; topics of theoretical interest in monetary policy formation and implementation.

ECON 440 International Economics. (3) Prerequisite, ECON 201, 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.

ECON 450 Introduction to Public Finance. (3) Prerequisite, ECON 201, 203; or ECON 205. The role of federal, state, and local governments in meeting public wants. Analysis of tax theory and policy, expenditure theory, government budgeting, benefit-cost analysis, and income redistribution.

ECON 451 Theory of Public Finance. (3) Prerequisite, ECON 403 and 450, or consent of instructor. Advanced analysis of government economic policy. Tax shifting and incidence, pollution control, anti-poverty policies, public goods theory. Applications to problems of individual interest to students.

ECON 454 State and Local Public Finance. (3) Prerequisite, ECON 201, 203, or 205. Principles and problems of governmental finance with special reference to state and local jurisdictions. Topics to be covered include taxation, expenditures and intergovernmental fiscal relations.

ECON 460 Industrial Organization. (3) Prerequisite, ECON 201, 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.

ECON 461 Economics of American Industries. (3) Prerequisite, ECON 201, 203, or 205. A study of the technology, economics and geography of representative American industries.

ECON 470 Labor Economics. (3) Prerequisites—ECON 201, 203, or ECON 205. A survey of labor force growth and composition, problems of unemployment and labor market operations, theories of wage determination, the wage-price spiral, collective bargaining, governmental regulation of employment and labor relations, and the history and characteristics of the American labor movement.

ECON 471 Current Problems in Labor Economics. (3) Prerequisite, ECON 470. For students who wish to pursue, in depth, selected topics in the labor field. Issues and topics selected for detailed examination may include: manpower training and development, unemployment compensation and social security, race and sex discrimination in employment, wage theory, productivity analysis, the problems of collective bargaining in public employment, wage-price controls and incomes policy.

ECON 475 Economics of Poverty and Discrimination. (3) Prerequisite, ECON 201, 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.

ECON 480 Comparative Economic Systems. (3) Prerequisite, 201, 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.

ECON 482 Economics of the Soviet Union. (3) Prerequisite, ECON 201, 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.

ECON 484 The Economy of China. (3) Prerequisite, ECON 201, 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" will be covered in review of the problems and prospects of the present Chinese economy.

ECON 486 The Economics of National Planning. (3) Prerequisite, ECON 201, 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.

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.

ECON 491 Regional and Urban Economics. (3) Prerequisite, ECON 401, or consent of the instructor. Study of the theories, problems and policies or urban and regional economic development.

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.

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 empirial macroeconomic models. Also included are material on wages and employment and on international and domestic stability.

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.

ECON 604 Advanced Micro-Economic Analysis. (3) Second semester. 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 economies.

ECON 605 Welfare Economics. (3) First semester. 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.

ECON 606 History of Economic Thought. (3) First semester. 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.

ECON 607 Economic Theory in the Nineteenth Century. (3) Second semester. Prerequisite, ECON 606 or consent of the instructor. A study of nineteenth-century and twentieth-century schools of economic thought, particularly the classicists, neo-classists, Austrians, German historical school, American economic thought, the socialists, and Keynes.

ECON 611 Seminar in American Economic Development. (3)

ECON 613 Origins and Development of Capitalism. (3) Second semester. 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.

ECON 615 Economic Development of Underdeveloped Areas. (3) First semester. 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.

ECON 616 Seminar in Economic Development. (3) Second semester. 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.

ECON 617 Money and Finance in Economic Development. (3) First semester. 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.

ECON 621 Quantitative Economics I. (3) First semester. 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.

ECON 622 Quantitative Economics II. (3) Second semester. 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.

ECON 655 Case Studies in Government Resource Allocation. (3) Case studies in cost-benefit analysis of government programs and projects as a basis for the program budget system; an analysis of resource management in the public sector of the economy.

ECON 656 Public Sector Workshop. (3) Second semester. Representative problems in analysis for public decision making: measurement of benefits and costs; in commensurabilities 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) First semester. Prerequisite, ECON 401 and 403 or consent of instructor. Analysis of market structure and its relation to market performance.

ECON 662 Industrial Organization and Public Policy. (3) Second semester. 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.

ECON 671 Seminar in Labor Economics. (3) First semester. 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.

ECON 672 Selected Topics in Labor Economics. (3) Second semester. 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.

ECON 682 Seminar in Economic Development of the Soviet Union. (3) Second semester. 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.

ECON 686 Economic Growth in Mature Economies. (3) First semester. Analysis of policies and problems for achieving stable economic growth in mature economics such as the United States, and the major West European countries.

ECON 698 Selected Topics in Economics. (3)

ECON 705 Seminar in Institutional Economic Theory. (3) Second semester. A study of the recent developments in the field of institutional economic theory in the United States and abroad.

ECON 706 Seminar in Institutional Economic Theory. (3)

ECON 721 Econometrics I. (3) First semester. 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.

ECON 722 Seminar in Quantitative Economics. (3) Second semester. 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.

ECON 725 Advanced Mathematical Economics. (3) First semester. 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.

ECON 726 Seminar in Mathematical Economics. (3) Second semester. Prerequisite, ECON 725.

ECON 731 Monetary Theory and Policy. (3) First semester. An adequate knowledge of micro- and macro-economics 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.

ECON 732 Seminar in Monetary theory and Policy. (3) Second semester. 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.

ECON 741 Advanced International Economic Relations. (3) First semester. 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.

ECON 742 Seminar in International Economic Relations. (3) Second semester.

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.

ECON 752 Seminar in Public Finance. (3) Second semester. 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.

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.

ECON 776 Seminar in the Economics of Human Resources. (3) Prerequisite, consent of instructor.

ECON 790 Advanced Urban Economics. (3) Market processes and public policies as related to urban problems and metropolitan change.

Employment, housing, discrimination, transportation and the local public sector

ECON 791 Advanced Regional and Urban Economics. (3) First semester. 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.

ECON 792 Seminar in Regional and Urban Economics. (3) Second semester. Selected topics and techniques in regional and urban economic analysis, including models for economic projections, urban growth, and regional development.

ECON 799 Master's Thesis Research. (1-6)

ECON 899 Doctoral Dissertation Research. (1-8)

Electrical Engineering Program

Acting Chairman: Gross

Professors: Caceres,[1] DeClans, Hochuli, Ligomenides, Newcomb, Reiser,[2] Taylor, Wagner, Weiss[3]

Associate Professors: Basham, Emad, Ephremides, Harger, Kim,[2] Lee, W. Levine, Pugsley, Rao, Rhee, Simons, Torres, Tretter, Zajac, Zaki

Assistant Professors: Baras, Boston, Eden, Gallman, O'Grady, Paez, Silio, Striffler

Research Instructor (visiting): Lin

[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) applied mathematics, b) biomedical engineering, c) circuits, d) communication, e) computers, f) control and g) 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.

The Applied Mathematics option is part of the University-wide interdisciplinary applied mathematics curriculum. This includes studies on algebraic systems, infinite dimensional systems, statistical estimation and the operator theory of networks.

In Biomedical Engineering, areas of study include neural electrophysiology, transduction and neural coding of sensory events, neural control of movement, muscle contraction and mechanics, instrumental techniques and processing in health care delivery 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 computer structures, 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, control of stochastic, and microminiature systems, ecological systems, control of distributed parameter systems and system identification.

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 applications 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 up-to-date research laboratories and computational facilities within the department. The Biomedical Laboratory is equipped with instrumentation 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 Computer Architecture Design Laboratory includes a PDP 11/40 for studies on computer structures. 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.

(See ENEE for optional related laboratory course.) Prerequisite, ENEE 314 or 410 or equivalent. Bistable, monostable, and astable circuits, sweep circuits, synchronization, counting, gates, comparators. Magnetic core circuits, semi-conductor 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 in switching circuits, bistable, monostable, and a stable circuits, sweep circuits, gates, comparators.

ENEE 404 Radio Engineering. (3) Prerequisite: ENEE 314. Tuned circuit amplifiers, single, double, and stagger tuned circuits; class amplifiers; frequency multipliers; amplitude modulation; modulators and detectors; receiver design and characteristics, frequency modulation, FM transmitters and receivers.

ENEE 405 Advanced Radio Engineering Laboratory. (1) Two hours of laboratory per week. Corequisite: ENEE 404. Experiments on multiple tuned amplifiers, noise figure measurements, classic amplifiers, varactors, modulators, projects.

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 complex variables, inverse La Place transforms. Applications are drawn primarily from circuit analysis.

ENEE 407 Microwave-Circuits Laboratory. (2) Prerequisite, senior standing in electrical engineering or consent of instructor. One lecture and three lab hours per week. Experiments concerned with circuits constructed from microwave components providing practical experience in the design, construction and testing of such circuits. Projects include microwave filters and S-parameter design with applications of current technology.

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) Corequisite, ENEE 314. One lecture and three 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) Prerequisite: ENEE 304. Network properties: linearity, reciprocity, etc.; 2-part descriptions and generalization. Y, S, hybrid matrices, description properties: symmetry, para-unity, etc.; basic topological analysis; state-space techniques; computer-aided analysis; sensitivity analysis; approximation theory.

ENEE 416 Network Synthesis. (3) Prerequisite, ENEE 304. Active and passive components, passivity, bounded and positive real, RC properties and synthesis, Brune and Darlington synthesis, transfer-voltage and Y21 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) Prerequisite, ENEE 324. Random signals: elements of random processes, noise, Gaussian process, correlation functions and power spectra, linear operations; optimum receivers, vector waveform channels, receiver implementation, probability of error performance; efficient signaling; sources, encoding, dimensionality, channel capacity; wave form communication: linear, angle, and pulse modulation.

ENEE 421 Introduction to Information Theory. (3) Prerequisite, ENEE 324. Definition of information and entropy; characterization of sources; Kraft and MacMillan inequalities; coding information sources; 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 324. 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. (4) 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. Prerequisites, ENEE 300 or 308, PHYS 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 potentiometric measurements; bridge measurements, time and frequency measurements, waveform generation and display.

ENEE 434 Introduction to Neural Networks and Signals. (3) Prerequisite, ENEE 204 or 300. Introduction in the generation and processing of bioelectric signals including structure and function of the neuron, membrane theory, generation and propagation of nerve impulses, synaptic mechanisms, transduction and neural coding of sensory events, central nervous system processing of sensory information and correlated electrical signals, control of effector organs, muscle contraction and mechanics, and models of neurons and neural networks.

ENEE 435 Electrodes and Electrical Processes in Biology and Medicine. (3) Prerequisite, ENEE 204 or 300. Techniques for recording biological signals such as brain, muscle and cardial electrical potentials; membrane theory; half-cell potentials, liquid junction potentials, polarization of electrodes; biological and medical instrumentation; and applications in the design of cardial pacemakers, or a similar case study.

ENEE 438 Topics in Biomedical Engineering. (1-3) Prerequisite, permission of the instructor. May be taken for repeated credit. The content may vary from semester to semester. Selected topics of current interest from such areas as bioelectric systems modeling instrumentation, automated diagnostic, health-care delivery, etc. Repeatable to a maximum of 9 hours.

ENEE 440. Digital Computer Organization. (3) Prerequisite, CMSC 210 or ENES 243 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.)

ENEE 442 Software Engineering. (3) Prerequisite, ENES 240; ENEE 250 or equivalent. Architectural aspects of software engineering. Machine language and machine structure; assembly language and assemblers; macro-language and macro-processors; loaders and linkers; programming languages and language structure; compilers and interpreters; operating systems.

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 software 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 444. One lecture and three 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 design techniques and applications of current technology.

ENEE 446 Computer Architecture. (3) Prerequisite, ENEE 250. Digital computer organization; arithmetic hardware; primary and secondary storage organization; read-only and associative memories; introduction to multiprocessor and multi-programming computer systems; interaction of hardware and software.

ENEE 450 Introduction to Discrete Structures. (3) Prerequisite, ENES 243 or equivalent. Review of set algebra including relations, partial ordering and mappings. Algebraic structures including semigroups and groups. Graph theory including trees and weighted 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 310. Programming the analog computer; analog computing components; error analysis, repetitive operation; synthesis of systems using the computer; hybrid computer systems.

ENEE 460 Control Systems. (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 460. One lecture and three 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 Systems, Control and Computation. (3) Prerequisite, ENEE 322 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 LaPlace 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 in transformers, synchronous machines, induction motors, synchros, loudspeakers, other transducers.

ENEE 480 Fundamentals of Solid State Electronics. (3) Prerequisite, ENEE 381. Review of Maxwell's equation, electromagnetic properties of dielectrics; introduction to quantum mechanics and quantum statistics, classical and quantum theory of metals; theory of semiconductors and semiconductor devices, principle of magnetic devices 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; aperature antennas; terminal impedance; propagation.

ENEE 483 Electromagnetic Measurements Laboratory. (2) Prerequisites, ENEE 305 and ENEE 380. One lecture and three 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 six credits, with the permission of the student's advisor and the instructor.

ENEE 496 Physical Electronics of Devices. (3) Pre- or corequisite, ENEE 381. Three lecture hours per week. Optical resonators, Fabry-Perot etalon. Theory of laser oscillation, rate equations. Gaseous, solid state, semiconductor and dye laser systems. Electro-optic effects and aparametric oscillators. Holography.

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 realiability 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 circuit 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, signal-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 repeated credit.

ENEE 609 Projects in Microwave-Circuits. (1-3) Prerequisite, ENEE 407 or consent of instructor. Individual projects on microwave circuits. Repeatable up to a maximum of six credits.

ENEE 610 Electrical Network Theory. (3) Undergraduate circuit theory or consent of the instructor. Matrix algebra, network elements, ports, passivity and activity, geometrical and analytical descriptions of networks, state variable characterizations, scattering matrices, signal flow graphs, sensitivity.

ENEE 620 Random Processes in Communication and Control. (3) Prerequisite, ENEE 324 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, non-linear operations in 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, applications to coherent and incoherent signal detection; M-ary hypotheses, application to uncoded and coded 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 Nerves and Muscles with Applications to Prosthetic Devices. (3) Prerequisite, undergraduate degree in engineering or physics, or permission of the instructor. Principles and circuit models for resting and active membrane potentials of nerves and muscles, synaptic mechanisms including probabilistic models of neuromuscular transmission; electrode potentials and reactions; propagation of biopotentials in a volume conductor; properties, mechanical models, and circuit analogs for muscles and proprioceptors; spinal reflexes in the control of posture; applications of the above in the design of prosthetic and orthotic devices.

ENEE 634 Models of Transduction and Signal Processing in Sensory Systems. (3) Prerequisite: ENEE 633 or ENEE 435 or permission of the instructor. General organization of sensory systems; receptor mechanisms; receptor and neural models; statistics of neural spike trains, peripheral signal processing in sensory systems, with emphasis on vision and audition; introduction to signal processing in the central nervous system; applications to development of sensory protheses.

ENEE 640 Arithmetic and Coding Aspects of Digital Computers. (3) Prerequisite, ENEE 440 or 445 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 642 Software System Implementation. (3) Prerequisite, ENEE 442 or equivalent. Implementation aspects of software engineering. Programming languages; architectural design; program design; structured programming; peripheral storage devices; I/O programming, debugging and evaluation.

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; multi-valued

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 for 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 language and examples of its use. Class will run simulation programs on a large-scale computer.

ENEE 660 Control System Analysis and Synthesis. (3) Prerequisite, Undergraduate automatic control theory background or consent of instructor. The linear regulator problem (finite and infinite time), optimal regulation with a prescribed degree of stability, relation of the optimal regulator to classical control specifications, sensitivity of optimal regulators, state estimators and their use in system design, optimal regulators with input disturbances, tracking systems. Course includes a brief review of classical design techniques, signal flow graphs, error coefficients and an introduction to sampled-data systems.

ENEE 661 Non-Linear and Adaptive Control Systems. (3) Prerequisite, undergraduate background in linear control theory or consent of instructor. Brief review of the state space, state plane and phase plane. Linearization and stability in the small, equivalent linearization and the describing function, systems with stochastic inputs, exact methods of analysis, stability in the large and the second method of Iyapono v. frequency domain stability criteria, Povo's method and its extensions, introduction to optimum switched systems, stability of systems with input.

ENEE 662 Sampled-Data Control Systems. (3) Prerequisite, preparations in linear feedback control theory or consent or instructor. Z-transform and modified Z-transform method of analysis, root locus and frequency response methods of analysis, ideal and finite width sampling, discrete and continuous compensation of digital control systems, state space equations, controllability and observability of discrete systems, stability, minimum time and minimum energy control, statistical design and the discrete Kalman filter.

ENEE 663 System Theory. (3) Modelling of systems, abstract definition of state, linearity and its implications, linear differential systems, controllability and observability, impulse response, 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, LaGrange equations, inequality constraint, maximum principle, Hamilton-Jacobi theory, dynamic programming, adaptive and stochastic control, filtering theory.

ENEE 680 Electromagnetic Theory I. (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, functionals, integral equations, and calculus of 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 electrical engineering point of view. Topics included: general principles of quantum mechanics, operator algebra, the microwave resonant cavity and the analagous 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 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 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 decoding, concatenated codes, P-N sequences, arithmetic codes.

ENEE 724 Digital Signal Processing. (3) Prerequisite, ENEE 620 or consent of instructor. Review of Z transforms; correlation functions and power spectral densities for discrete time stochastic processes; discrete time Wiener filters; methods for designing digital filters to meet precise frequency domain specification; effects of truncation, round-off and finite word length arithmetic on the accuracy and stability of digital filters; adaptive equalizers for narrow band data channels; discrete Fourier transform and fast Fourier transform; homomorphic filtering; Gauss-Markov estimates; spectral density estimation.

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. Classiciations, 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 772 Mathematical Models in Estimation Theory. (3) Abstract measures, probability measures on function spaces, integration; Markov processes, stochastic differential equations, Ito's rule; Kalman-Bucy model; duality of estimation and control, singular detection, point processes; RKHS, linear theory, multiplicity representations; additional models and applications. Required background: functional analysis, real analysis, random processes.

ENEE 774 Mathematics of Continuous Networks. (3) Nonoriented systems, ports, linear orientations, theory of distributions, scattering matrices, operator theory of networks, activity, invariant embedding, multivariable PR and BR state-determined systems, synthesis, interval functions, tolerance analysis, neuron networks and models, Manley-Rowe relations, oscillators and nonlinear subharmonic generation.

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 guidesand 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 I. (3) Two lectures per week. Prerequisite, a knowledge of quantum mechanics and electromagnetic theory. Spontaneous emission, interaction of radiation and matter, masers, optical resonators, the gas, solid and semi-conductor lasers, electro-optical effect, propagation in aniso tropic media and light modulation.

ENEE 791 Quantum Electronics II. (3) Nonlinear optical effects and devices, tunable coherent 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

Professors: Armstrong (Mech. Eng.), Arsenault, (Chem. Eng.), Bolsatis (Chem. Eng.), Marcinkowski; (Mech. Eng.), Skolnick (Chem. Eng.), Spain (Chem. Eng.)

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 Director, 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 Engineering 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) Equilbrium 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. (3) 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 optional 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, precipation, 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, ENCH 620. 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.

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, ENCH 620. 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 Dissertation Research. (1-8)

Engineering Science Courses

ENES 401 Technological Assessment. (3) Prerequisite, senior standing or consent of instructor. Analysis of assessing technology in terms of goals and resources. Public and private constraints, changes in objectives and organization. Applications to engineering technology.

ENES 405 Power and the Environment. (3) Prerequisite, junior standing or consent of the instructor. An introduction to the power needs of society. The interrelationship between man's use of energy and the effect on the ecosystem. Introduction to the techniques of power production with special emphasis on nuclear fueled power plants.

ENES 473 Principles of Highway and Traffic Engineering. (3) Prerequisites, permission of instructor. 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 implementation 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, Freedman, Hovey, Isaacs, Lawson, Lutwack, Manning, McManaway, Mish, Murphy, Myers, Panichas, Perloff, Russell, Salamanca, Schoeck, Schornhorn, Whittemore
Associate Professors: Barnes, Barry, Birdsall, Brown, Coogan, Cooper, Fry, Greenwood, Hamilton, Holton, Houpert, Howard, Jellema, Kinnaird, Kleine, Mack, Miller, Peterson, Portz, Smith, Thorberg, Vitzthum, Ward, Wilson
Assistant Professors: Cate, Gallick, Hamilton, James, 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: Engish 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 300 and 400 Level course prerequisites, any two freshman or sophomore English courses, with the exception of ENGL 293 and ENGL 294.

ENGL 401 English Medieval Literature in Translation. (3)

ENGL 402 Chaucer. (3)

ENGL 403 Shakespeare. (3) Early period: histories and comedies.

ENGL 404 Shakespeare. (3) Late periods: tragedies and romances.

ENGL 405 The Major Works of Shakespeare. (3) Students who have credit for ENGL 403 or 404 cannot receive credit for ENGL 405.

ENGL 407 Literature of the Renaissance. (3)

ENGL 410 Edmund Spenser. (3)

ENGL 411 Literature of the Renaissance. (3)

ENGL 412 Literature of the Seventeenth Century, 1600-1660. (3)

ENGL 414 Milton. (3)

ENGL 415 Literature of the Seventeenth Century, 1660-1700. (3)

ENGL 416 Literature of the Eighteenth Century. (3) Age of Pope and Swift.

ENGL 417 Literature of the Eighteenth Century. (3) Age of Johnson and the Preromantics.

ENGL 418 Major British Writers. (3) Two writers studied intensively each semester.

ENGL 419 Major British Writers. (3) Two writers studied intensively each semester.

ENGL 420 Literature of the Romantic Period. (3) First generation: Blake, Wordsworth, Coleridge, et. al.

ENGL 421 Literature of the Romantic Period. (3) Second generation: Keats, Shelly, Byron, et. al.

ENGL 422 Literature of the Victorian Period. (3) Early years.

ENGL 423 Literature of the Victorian period. (3) Middle years.

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.

ENGL 425 Modern British Literature. (3) An historical survey of the major writers and literary movements in English prose and poetry since 1900.

ENGL 430 American Literature, Beginning to 1810, the Colonial and Federal Periods. (3)

ENGL 431 American Literature, 1810 to 1865, the American Renaissance.

ENGL 432 American Literature, 1865 to 1914, Realism and Naturalism. (3)

ENGL 433 American Literature, 1914 to the Present, The Modern Period. (3)

ENGL 434 American Drama. (3)

ENGL 435 American Poetry—Beginning to the Present. (3)

ENGL 436 The Literature of American Democracy. (3)

ENGL 437 Contemporary American Literature. (3) A survey of the poetry, prose,

and drama written in America in the last decade.

ENGL 438 Major American Writers. (3) Two writers studied intensively each semester.

ENGL 439 Major American Writers. (3) Two writers studied intensively each semester.

ENGL 440 The Novel in America to 1910. (3)

ENGL 441 The Novel in America Since 1910. (3)

ENGL 442 Literature of the South. (3) A historical survey, from eighteenth-century beginnings to the present.

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.

ENGL 444 Experimental Approaches to Literature—Emerson to Thoreau. (3) Variable subject matter presented in experimental methods and approaches. Grading in satisfactory/fail only. Consent of instructor required for admission.

ENGL 445 Modern Poetry. (3)

ENGL 449 Playwriting. (3)

ENGL 450 Elizabethan and Jacobean Drama. (3) Beginnings to Marlowe.

ENGL 451 Elizabethan and Jacobean Drama. (3) Jonson to Webster.

ENGL 452 English Drama from 1660 to 1800. (3)

ENGL 453 Literary Criticism. (3)

ENGL 454 Modern Drama. (3)

ENGL 455 The English Novel. (3) Eighteenth Century.

ENGL 456 The English Novel. (3) Nineteenth Century.

ENGL 457 The Modern Novel. (3)

ENGL 460 Introduction to Folklore. (3)

ENGL 461 Folk Narrative. (3) Studies in legend, tale and myth. Prerequisite, ENGL 460.

ENGL 462 Folksong and Ballad. (3) Prerequisite, ENGL 460.

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.

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.

ENGL 465 Urban Folklore. (3) Prerequisite, ENGL 460. An examination of the folklore currently originating in white, urban, American culture.

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.

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.

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.

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

ENGL 482 History of the English Language. (3)

ENGL 483 American English. (3)

ENGL 484 Advanced English Grammar. (3) Credit may not be granted in both ENGL 484 and LING 402.

ENGL 485 Advanced English Structure. (3)

ENGL 486 Introduction to Old English. (3) An introduction to the grammar, syntax, and phonology of Old English. Selected readings from Old English prose and poetry.

ENGL 489 Special Topics in English Language. (3) Studies in topics of current interest; repeatable to a maximum of 9 hours.

ENGL 493 Advanced Expository Writing. (3)

ENGL 498 Creative Writing. (3)

ENGL 499 Advanced Creative Writing. (3)

ENGL 601 Bibliography and Methods. (3)

ENGL 602 Middle English. (3)

ENGL 603 English Language—Old English to Early Modern English. (3)

ENGL 604 Old English. (3) Grammar, syntax, phonology and prosody of Old English. Designed to give graduate students a working knowledge of Old English and to introduce them to the major Old English texts in the original.

ENGL 611 Approaches to College Composition. (3) A seminar emphasizing rhetorical and linguistic foundations for the handling of a course in freshman composition. For graduate assistants (optional to other graduate students).

Special Studies in English Literature—The Medieval Period to 1500. (3)

ENGL 621 Special Studies in English Literature—Renaissance Literature. (3)

ENGL 622 Special Studies in English Literature—17th Century Literature. (3)

ENGL 623 Special Studies in English Literature—18th Century Literature. (3)

ENGL 624 Special Studies in English Literature—Romantic Literature. (3)

ENGL 625 Special Studies in English Literature—Victorian Literature. (3)

ENGL 626 Special Studies in American Literature—American Literature Before 1865. (3)

ENGL 627 Special Studies in American Literature—American Literature Since 1865. (3)

ENGL 718 Seminar in Medieval Literature. (3)

ENGL 719 Seminar in Renaissance Literature. (3)

ENGL 728 Seminar in Seventeenth-Century Literature. (3)

ENGL 729 Seminar in Eighteenth-Century Literature. (3)

ENGL 738 Seminar in Nineteenth-Century Literature. (3)

ENGL 739 Seminar in Nineteenth-Century Literature. (3)

ENGL 748 Seminar in American Literature. (3)

ENGL 749 Studies in Twentieth-Century Literature. (3)

ENGL 758 Literary Criticism. (3)

ENGL 759 Seminar in Literature and the Other Arts. (3)

ENGL 768 Studies in Drama. (3)

ENGL 769 Studies in Fiction. (3)

ENGL 778 Seminar in Folklore. (3)

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, Caron, Harrison, Jones, Menzer, Messersmith, Steinhauer, Wirth
Associate Professor: Davidson, Reichelderfer
Assistant Professors: Miller
Lecturers: Heimpel, Spangler

The Department of Entomology offers both the M.S. and the Ph.D. degrees. Graduate students may specialize in physiology and morphology, toxicology, biosystematics, ecology and behavior, medical entomology, apiculture, insect pathology, and economic entomology. Normally, students must acquire the master's degree before being admitted to the doctoral program. The M.S. degree is awarded following the successful completion of the course requirements and a satisfactory thesis. A non-thesis M.S. option is available for those interested in qualifying as pest management specialists. In this program a field experience course including a comprehensive report is substituted for the thesis.

Students applying for graduate work in entomology are expected to have strong backgrounds in the biological sciences, chemistry and mathematics. Since the department is particularly anxious to find strong basic preparation, an undergraduate major in entomology is not required for admission to the program. It should be understood, however, that the lack of certain specific courses taken in the undergraduate program will extend the period of time required for the M.S. degree. Students in entomology are frequently employed as Graduate Assistants, or find part-time employment in laboratories in the area.

The student is given great latitude in the selection of the advisory study committee, choice of the major study areas and supporting course work, and choice of the research problem. The demonstration of competence in one foreign language is required for the Ph.D. Upon admission to the Ph.D. program, the student is given a preliminary interview (which may be combined with the M.S. final oral examination) in which the program of course work and collateral reading, the plan for demonstration of competence in the foreign language chosen, and the general outline of the proposed research area are established and approved. Following the completion of most course work and the demonstration of foreign language competency, the oral qualifying exam-

ination is administered before the student applies for admission to candidacy.

Facilities are maintained in the department for research in all areas of specialization offered, and in addition, cooperative programs with other departments in Agricultural and Life Sciences are possible. Cooperative research programs are often maintained by the department with several government agencies, such as the Beltsville Agricultural Research Center, the U.S National Museum of Natural History, and the Walter Reed Army Institute of Research. Specialized facilities are frequently made available to graduate students in these programs. In many instances graduates of the programs in entomology find employment in such government agencies because of the contacts made in these cooperative projects.

The Department's "Guidelines for Graduate Students" give additional information on the graduate program, including requirements for admission, course requirements, examinations, seminars, and research areas and facilities. Copies 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 three-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 ADN two three-hour laboratory periods a week. Prerequisite, ENTM 204. 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 three-hour laboratory periods a week Prerequisite, ENTM 204. A basic study of insect form, structure and organization in relation to function.

ENTM 442 Insect Physiology. (4) Prerequisites, ENTM 204 and CHEM 104 or equivalent. Three lectures and one three-hour laboratory per week. Functions of internal body systems in insects.

ENTM 451 Economic Entomology. (4) Two lectures and two two-hour laboratory periods a week. Prerequisite, ENTM 204. 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, compatability, and host injury. Recent Research emphasized.

ENTM 453Insect Pest of Ornamental Plants. (3) Prerequisite, ENTM 204 Two lectures and one 3-hour laboratory period a week The recognition, biology and control of insects and mites injurious to ornamental shrubs, trees and greenhouse crops. Emphasis is placed on the pests of woody ornamental plants.

ENTM 462 Insect Pathology. (3) Two lectures and one three-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 two-hour laboratory period a week. Prerequisite, ENTM 204 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.

EMTM 612 Insect Ecology. (2) Second semester. One lecture and one two-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) First semester One Three-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) First semester, alternate years. 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) First semester. 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) First Semester Three lectures and one three-hour laboratory period a week. (Alternate years, not offered 1975-1976) 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) Second semester, alternate years (offered 1975-1976), 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) Second semester. One lecture and one three-hour laboratory period a week. (Alternate years.) The classification, distribution, ecology, biology, and control of mosquitoes.

ENTM 689 Entomological Topics. (1-2) First and second semesters 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 798 Field Experience in Pest Management. (1-6)

ENTM 799 Master's Thesis Research. (1-6)

ENTM 899 Doctoral Dissertation Research. (1-8)

Family and Community Development Program

Associate Professor and Chairman: Gaylin
Associate Professors: Brabble, Lemmon†, Myricks, Wilson
Assistant Professors: Churaman, Rubin

A Master of Science Degree in Family and Community Development is offered under a revised graduate program within the College of Human Ecology. The revised program is particularly responsive to the contemporary needs of families and the most effective ways of providing programs and services in the community.

The program objectives of the Department of Family and Community Development are directed toward educating 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 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 agents of change, through the family unit.

An integrated practicum experience is offered which enables students to work directly with families and community agencies.

The total Master's program is 30 hours. The student may choose either the Thesis or Non-thesis option. Six hours of Thesis Research are required for those students selecting the thesis option. The non-thesis option permits more extensive field experience in lieu of the research thesis. Any student selecting this option will complete 30 hours of course work

with a comprehensive examination upon completion.

The department will continue to adopt the policies of the Graduate School as the basic criteria for admission to the Master's program In addition, it is recommended that individuals take the Aptitude section of the GRE, and have adequate undergraduate preparation in one or more of the following areas: family development, psychology, sociology, or human ecology A course in elementary statistics at the undergraduate level is also desirable.

Due to the limited number of available Graduate Teaching Assistantships, and the high demand, application for financial aid should be made prior to April 1st, for the fall semester of the coming year.

Further information regarding this program should be obtained by contacting the department or the College of Human Ecology directly.

FMCD 431 Family Crises and Rehabilitation. (3) Deals with various types of family crises situations and how families cope with the rehabilitation process. It covers issues at various stages of the family cycle ranging from divorce, teenage runaways, abortion, to the effect of death on a family. Role playing and interviewing techniques are demonstrated and ways of helping the family through the crises are emphasized.

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

FMCD 446 Living Experiences With Families. (3-6) A—Domestic Intercultural, B—International Intercultural. Prerequisites, FMCD 330, ANTH 101; FMCD 250; Optional, language competence. An individual experience in living with families of a sub-culture within the U.S. or with families of another country, participating in family and community activities. A foreign student may participate and live with an American family.

FMCD 447 Home Management For the Disabled. (3) Application of home management concepts in the use of resources to promote maintenance of homemaker independence through physiological and psychological adjustments in the family and home environment. The purpose of this course is to prepare students for working effectively with disabled homemakers.

FMCD 448 Selected Topics in Home Management. (3) Seminar format will be used to examine the ways families set priorities and organize their efforts and resources to achieve both social and economic goals. Prior registration in FMCD 250, 341, or other courses in management theory. Systems analysis or research methods is desirable, Repeatable for a maximum of 6 credits provided subject matter is different.

FMCD 485 Introduction To Family Counseling. (3) Provides the Fundamental theoretical concepts and clinical procedures that are unique to marital and family therapy. These techniques are contrasted with individually-orientated psychotherapy. Pre-marital, marital and divorce counseling techniques are demonstrated and evaluated.

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.

FMCD 600 Readings in Research and Theory of The Family (3) Emphasis is placed on surveying current research, concepts and theory in marital and family dynamics. The relationship of the contemporary family to the society and community are discussed and family patterns within various social classes and across different cultures are compared. Changes in family functioning throughout the family life cycle and over the last hundred years are described and analyzed

FMCD 602 Integrative Aspects of Home Economics (3) The philosophical foundation for the home economics profession are explored in this course. An historical approach is used in part to indicate the growth of home economics, its relationship to other disciplines and its integrative function for the practitioner of the applied human sciences. Emphasis is placed upon recent trends and future directions for the professional as change agent and his role within society.

FMCD 609 Seminar: Current Issues in Family and Community Development (1-4) This seminar will be open to all graduate students for non-credit or variable credit by prior arrangement. It is considered an informal vehicle to generate communication and discussion among all members of the department. Presentations will include reviews and critiques of recent articles and books within the field and those relevant to it. In addition, original informal discussion papers from faculty and students will be generated for presentation and discussion. Guest speakers and discussants will be encouraged when deemed appropriate.

FMCD 610 Familimetrics (3) Prerequisites, FMCD 401 and statistics. The primary focus is on the advantages and limitations of family research procedures and the degree of correspondence between these methods. Ways of developing and evaluating adequate research procedures will be emphasized and recent innovations in the field will be considered.

FMCD 615 Community Interaction With Families (3) A study of relationships of the individual within the family and involvement with the community. 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. Theoretical frameworks are to be developed with effective operational approaches applied in local community organizations. Students will participate in studying available community groups and their effects on individuals. Governmental agency programs and funded community projects will be studied, with special attention given to the philosophy of various funding agencies.

FMCD 625 Advanced Consumer Affairs. (3) An analysis of current consumer behavior found in various family life styles and of community processes for dealing with consumer problems. Emphasis is given to recent research and theoretical frameworks in the consumer area.

FMCD 660 Program Planning and Evaluation. (1-6) Consideration is given to research program development and/or evaluation of an existing research program in relation to objectives and need. Reporting of research for publication in a journal and periodicals will also be stressed.

FMCD 668 Special Topics in Family Life. (1-6) Individual study or arranged group study.

FMCD 678 Special Topics in Community Services (1-6) Individual study or arranged group study.

FMCD 686 Introduction To Family Counseling. (3) This course gives the fundamental theoretical concepts and clinical procedures that are unique to family and marital therapy. Family and marital therapy are contrasted with individually-oriented psycho-therapy in terms of historical development, assumptions and techniques. Various types of clinical techniques for marital and family therapists are presented. Premarital, marital and family, divorce counseling approaches are considered.

FMCD 688 Special Topics in Management-Consumer. (1-6) Individual study or arranged group study

FMCD 691 Family-Community Consultation (3) The foci of this course are upon defining areas of behavior which can be referred to the family-community consultant and upon methodology which can be applied by the consultant to family or professional situations. Roles such as homemaker rehabilitation consultant could receive added emphasis through field experience participation which is encouraged in the course.

FMCD 695 Practicum in Family and Community Services (3) A field experience with provides one of the following. (1) direct contact with family life styles different from one's own (2) observation and/or (3) experience of a professional role in working with families (consulting, counseling, informal education, leadership training, community action, case work, etc.). Observation and/or experience with services, educational programs or action programs dealing with a particular type of family problem (financial, consumer, help in emergencies, health, housing, homemaker rehabilitation, family relationships and management) will be included

FMCD 698 Special Topics in General Human Ecology (1-6) Individual study or arranged group study.

FMCD 799 Master's Thesis Research. (1-6) Fire Protection, Engineering Courses.

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. Prerequisite, 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.

Food, Nutrition, and Institution Administration Program

Professor and Chairman: Prather
Associate Professors: Ahrens, Butler, Cox
Assistant Professors: Berdanier,
Lecturer: Mehlman, 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 440 Advanced Food Science. (3) Three lectures per week. Prerequisites, food 240, 250, CHEM 461 or concurrent registration. Chemical and physical properties of food as related to consumer use in the home and institutions.

FOOD 445 Advanced Food Science Laboratory (1) One three-hour laboratory per week. Prerequisite, CHEM 201 and consent of instructor. Chemical determination of selected components in animal and plant foods.

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 480 Food Additives. (3) Prerequisite, FOOD 440 or equivalent. Effects 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) 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) Second semester. 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) First semesler. 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) First semester, alternate years. Two lectures and one three-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) Second semester. 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. (1-5) Individual or group study in an area of foods.

FOOD 688 Seminar. (1-2) Reports and discussions of current research in foods. (1-2)

FOOD 799 Master's Thesis Research. (1-6)

Nutrition

NUTR 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.

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 two-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 patholobical 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 U.S. 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. For students in the coordinated undergraduate dietetics program twelve hours per week clinical experience is required and this course must be accompanied by NUTR 460.

NUTR 485 Applied Community Nutrition. (3) Prerequisite, NUTR 460 and concurrent registration in NUTR 470 (Open only to students accepted into and participating in the coordinated undergraduate program in dietetics). Application of principles in community nutrition through guided experiences in different aspects of nutrition programs in the community. Twelve hours of field experience per week is required.

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) First semester. 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) First and second semesters. Reports and discussions of significant nutritional research and investigation.

NUTR 620 Nutrition for Community Services. (3) First semester. 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) Second semester. 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 significance in nutrition.

NUTR 678 Special Topics in Nutrition. (1-6) Individual or group study in an area of nutrition.

NUTR 680 Human Nutritional Status. (3) First semester, alternate years. 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, prearation, 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 three-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 regulations, 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 Administrative Dietetics I. (3) (Open only to students accepted into and participating in the U.S. Army dietetic internship program at Walter Reed General Hospital or the coordinated undergraduate dietetics program.) Application of management theory through guided experience in all aspects of hospital dietary department administration. For students in the coordinated undergraduate dietetics program twelve hours per week of hospital food service management experience is required, and this course must be accompanied by IADM 300 and 430.

IADM 470 Administrative Dietetics II. (3) (Open only to students accepted into and participating in the U.S. Army dietetic internship program at Walter Reed General Hospital or the coordinated undergraduate dietetics program.) Continuation of IADM 460. For students in the coordinated undergraduate program twelve hours per week hospital food service experience is required and this course must be accompanied by IADM 420 and 440.

IADM 490 Special Problems in Food Service. (2-3) Prerequisites, senior standing, five hours in IADM course and consent of instructor. Individual selected problems in the area of food service.

IADM 600 Food Service Administration. (3) First or second semester. 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 administration.

IADM 630 Computer Application in Food Service. (3) Second semester, alternate years. 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) Second semester, alternate years. 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) First semester, alternate years. Two lectures and one three-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 semester hours of credit.

IADM 799 Master's Thesis Research. (1-6) First and second semesters. Credit in proportion to work done and results accomplished. Investigation in some phases of institution administration which may form the basis of a thesis.

Food Science Program

Professor and Chairman: King (Dairy Science)
Professors: Kramer, Stark, Twigg and Wiley (horticulture), Mattick (Dairy Science), Young (Animal Science), Keeney (Chemistry)
Associate Professors: Bigbee and Thomas (Poultry Science), Cowan (Agricultural Engineering), Buric (Animal Science), Bender (Agricultural and Resource Economics)
Assistant Professors: Heath (Poultry Science), Westhoff (Dairy Science)

The Food Science Program offers the Master of Science and Doctor of Philosophy degrees. This graduate program is interdepartmental with participation or support from the Departments of Animal Science, Dairy Science, Horticulture, Poultry Science, Agricultural Engineering, Chemistry, Microbiology, and Agricultural and Resource Economics and the Seafood Processing Laboratory of the Natural Resources Insitute. Areas of study encompass animal, plant and seafood products with specialization available in food chemistry, food microbiology, food engineering, quality control, nutrition, business management, and others.

Individual programs of study are developed by the student and an appropriate committee. A non-thesis Master of Science degree is available. Specific regulations for the Food Science Program have been formulated for the guidance of prospective candidates for graduate degrees. Copies are available from the Program Office.

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.

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.

FDSC 421 Food Chemistry. (3) Three lectures per week. Prerequisites, CHEM 203 and 204. The application of basic chemical and physical concepts to the composition and properties of foods. Emphasis on the relationship of processing technology, to the keeping quality, nutritional value, and acceptability of foods.

FDSC 422 Food Product Research and Development. (3) Two lectures, and one laboratory per week. Prerequisites, 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.

FDSC 423 Food Chemistry Laboratory. (2) Pre- or corequisite, FDSC 421. Two laboratories per week. Analysis of the major and minor constituents of food using chemical, physical and instrumental methods in concordance with current food industry and regulatory practices. Laboratory exercises coincide with lecture subjects in FDSC 421.

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, bioprocessing of foods, and public health significance.

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.

FDSC 432 Food Quality Control Laboratory. (2) Two laboratories per week. Prerequisite, concurrent registration in FDSC 431. Chemical-physical, instrumental, microanalytical, sensory analysis of food quality attributes. Using data obtained, calculate sampling plans, control charts, process capabilities, grades and standards.

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.

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.

FDSC 471 Meat and Meat Processing. (3) Two lectures and one laboratory a 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.

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 microorganisma, G—flavor and analysis, I—assays. Studies in depth of selected phases of food science are frequently best arranged by employment if 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) First and second semester. 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) First and second semesters. 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) First semester, alternate years. Prerequisite, CHEM 461 or permission of instructor. A systematic review of new products, processes and management practices in the food industry.

FDSC 899 Doctoral Dissertation Research. (1-8)

French and Italian Language and Literature Program

Professor and Chairman: MacBain
Professors: Bingham, Rosenfield
Associate Professors: Demaitre, Fink, Tarica
Assistant Professors: Gilbert, Hicks, Lebreton-Savigny, Meijer,

The department prepares students for the M.A. and Ph.D. degrees in French language and literature. Roughly half of the graduate students are offered financial support.

The composition of the Graduate 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. The M.A. program is generally completed in three to four semesters, or less if Summer Session offerings are utilized.

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 are then required to complete a program of seminars related to their field of interest and to pass five Special Topic examinations and a Foreign Language Proficiency examination before being admitted to candidacy and beginning work on their dissertation.

Complete information concerning the department's requirements are set forth in the *Guide to Graduate Programs in French*, available by writing to the Department of French Language and Literature, University of Maryland, College Park, Maryland 20742.

FREN 001 Elementary French for Graudate Students. (3) Intensive elementary course in the French language designed particularly for graduate students who wish to acquire a reading knowledge. This course does not carry credit towards any degree at the university.

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.

FREN 401 Introduction to Stylistics. (3) Prerequisite, FREN 302, or course chairman's consent. Comparative stylistic analysis; detailed grammatical analysis; translation.

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.

FREN 411 Introduction to Medieval Literature. (3) French literature from the ninth through the fifteenth century. La Chanson Epique, le Roman Courtois, le Lai; la Litterature Bourgeoise, le Theatre, la Poesie Lyrique.

FREN 412 Introduction to Medieval Literature. (3) French literature from the ninth through the fifteenth century. La Chanson Epique, le Roman Courtois, le Lai; la Litterature Bourgeoise, le Theatre, la Poesie Lyrique.

FREN 421 French Literature of the Sixteenth Century. (3) The Renaissance in France: Humanism, Rabelais, Calvin, the Pleiade, Montaigne, Baroque poetry.

FREN 422 French Literature of the Sixteenth Century. (3) The Renaissance in France: Humanism, Rabelais, Calvin, the Pleiade, Montaigne, Baroque poetry.

FREN 431 French Literature of the Seventeenth Century. (3) Descartes, Pascal, Corneille, Racine; the remaining great classical writers, with special attention to Moliere.

FREN 432 French Literature of the Seventeenth Century. (3) Descartes, Pascal, Corneille, Racine; the remaining great classical writers, with special attention to Moliere.

FREN 441 French Literature of the Eighteenth Century. (3) Development of philosophical and scientific movement; Montesquieu, Voltaire, Diderot, Rousseau.

FREN 442 French Literature of the Eighteenth Century. (3) Development of philosophical and scientific movement; Montesquieu, Voltaire, Diderot, Rousseau.

FREN 451 French Literature of the Nineteenth Century.)3) Drama and poetry from Romanticism to Symbolism; the major prose writers of the same period.

FREN 452 French Literature of The Nineteenth Century. (3) Drama and poetry from Romanticism to Symbolism; the major prose writers of the same period.

FREN 461 Studies in Twentieth Century Literature—The Early Years. (3) French poetry, theater and the novel during the age of Proust and Gide.

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.

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.

FREN 478 Themes and Movements of French Literature in Translation. (3) Studies treatments of thematic problems 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 491 Honors Reading Course, Poetry. (3) H—Honors, Poetry. Supervised readings to be taken normally only by students admitted to the honors program.

FREN 492 Honors Reading Course, Novel. (3) H—Honors, Novel. Supervised readings to be taken normally only by students admitted to the honors program.

FREN 493 Honors Reading Course, Drama. (3) H—Honors, Drama. Supervised readings to be taken normally only by students admitted to the honors program.

FREN 494 Honors Independent Study. (3) H—Honors. Honors independent study involves guided readings based on an honors reading list and tested by a 6 hour written examination. Honors 494 and 495 are required to fulfill the departmental honors requirement in addition to two out of the following: 491H, 492H, 493H. Open only to students admitted to the departmental honors program.

FREN 495 Honors Thesis Research. (3) H—Honors. Honors thesis research involves the writing of a paper under the direction of a professor in this department and an oral examination. Honors 494 and 495 are required to fulfill the departmental honors requirement in addition to two out of the following: 491H, 492H, 493H. Open only to students admitted to the departmental honors program.

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)

FREN 601 The History of the French Language. (3)

FREN 602 Comparative Romance Linguistics. (3) Also listed as SPAN 612.

FREN 603 Stylistics. (3) Advanced composition, translation, stylistic analysis.

FREN 609 Special Topic in the French Language.

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.

FREN 619 Special Topic in Medieval French Literature. (3)

FREN 629 Special Topic in Sixteenth Century French Literature. (3)

FREN 630 Corneille. (3)

FREN 631 Moliere. (3)

FREN 632 Racine. (3)

FREN 639 Special Topic in Seventeenth Century French Literature. (3)

FREN 640 Voltaire. (3)

FREN 641 Rousseau. (3)

FREN 642 Diderot. (3)

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)

FREN 653 The French Novel in the Nineteenth Century. (3)

FREN 659 Special Topic in Nineteenth Century French Literature. (3)

FREN 660 French Poetry in the Twentieth Century. (3)

FREN 662 The French Novel in the Twentieth Century. (3)

FREN 663 The French Novel in the Twentieth Century. (3)

FREN 664 The French Theatre in the Twentieth Century. (3)

FREN 665 The French Theatre in the Twentieth Century. (3)

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 is the presentation of elementary French courses to college age students.

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.

FREN 799 Master's Thesis Research. (1-6)

FREN 801 Independent Study. (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 802 Independent Study. (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. (1-8)

Italian

ITAL 410 The Italian Renaissance. (3) A study of major trends of thought in Renaissance literature, philosophy, art, and science.

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 Acting Chairman: Fonaroff
Professors: Ahnert, Deshler, Harper, Hu
Associate Professors: Brodsky, Chaves, Groves, Mitchell, Thompson, Wiedel
Assistant Professors: Dando, Lewis, Muller, Roswell

The programs for both the Master of Arts and Doctor of Philosophy degrees in the Department of Georgraphy are designed to provide the student with well-rounded competence in the field as well as opportunity for specilization.

Considering particular advantages inherent in the College Park location the department has built its graduate program around three major areas of concentration. In each, the department has assembled a group of faculty members with complementary and overlapping interests The areas are: (1) Physical Georgraphy with emphasis on physical systems involving the inter-relationships between geomorphology, climatology, and other environmental elements. The University's meteorology program and work in agriculture and biology provide support for this program as do various Federal Government environmental programs and the special consortium studying Chesapeake Bay and its resources. (2) Cultural Georgraphy, especially the historical geography of the United States and Canada. This specialty draws on the incomparable archival material in the Washington area, in state historical agencies, and in Baltimore. (3) the geography of Metropolitan Areas and urban systems supported by affiliation with the University's Institute for Urban Studies and regional and local planning agencies.

Individual faculty members have other interests that enable students to work on special programs such as human ecology, medical geography, Latin America, East Asia, the Soviet Union and cartography. But students planning such programs should contact the department or the interested faculty member to determine their feasibility.

While progress in the graduate program is largely an individual matter students entering the M.A. program should consider a two-year program normal; those entering the Ph.D. should think of three years as the norm.

Incoming M.A. students are expected to have an undergraduate degree in the field or in a closely related field, with substantial work in georgraphy. In the latter case, remedial work may be required prior to admission to the degree program. All graduate applicants should submit GRE examination results.

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 specilization. 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 U.S. and Canada from pre-Columbian times to the end of the 18th century. Emphasis on areal variations and changes in the settlements and economics 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 U.S. and Canada from 1800 to the 1920's. Emphasis on the settlement expansion and socio-economic development of the U.S., 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 economic 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 development 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 437 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 Cultural Ecology. (3) Basic issues concerning the natural history of man from the perspective of the geographer. Basic components of selected behavioral and natural systems, their evolution and adaptation, and survival strategies.

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 456 The Social Geography of Metropolitan Areas. (3) A socio-spatial approach to man's interaction with his urban environment; the ways people perceive, define, behave in, and structure their cities and metropolitan areas. Spatial patterns of social activities as formed by the distribution and interaction of people and social institutions.

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 distribution 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 representation of features of 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 basis for discussion. Research paper required.

GEOG 601 Field Course. (3)

GEOG 602 Proseminar in Cultural—Historical Geography. (3) An introductory graduate survey of the basic structure and recent trends in the field of cultural-historical geography. Emphasis on the theoretical principles and analytical procedures employed in researching cultural-historical problems and on literature which has resulted from this research.

GEOG 603 Proseminar in Urban-Economic Geography. (3) A survey of the basic structure and current trends in the field of urban geography; social and economic aspects. Major contributions to the literature, significant research frontiers, methodologies, analytical procedures and theories in the context of intra-urban and inter-urban problems and policies.

GEOG 604 Proseminar in Physical Geography. (3) A survey of the basic structure and recent trends in the fields of physical geography. Emphasis on general concepts in the field, its role as a study of the natural environment, its function within geography as a whole, and its research methods.

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 field 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 a 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) First and second semesters. 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) First and second semesters. Prerequisite, consent of instructor. Selected topics in meteorology and climatology chosen to fit the individual needs of advanced students.

GEOG 638 Seminar in Physical Geography. (3) Prerequisite, consent of instructor. An examination of themes and problems in the field of physical geography.

GEOG 639 Seminar in Physical Geography. (3) Prerequisite, consent of instructor. An examination of themes and problems in the field of physical geography.

GEOG 648 Seminar in Cultural Geography. (3) Prerequisite, GEOG 450 or consent of instructor. An examination of themes and problems in the field of economic geography.

GEOG 649 Seminar in Cultural Geography. (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 Seminar in Economic Geography. (3) Prerequisite, consent of instructor. An examination of themes and problems in the field of economic geography.

GEOG 669 Seminar in Economic Geography. (3) Prerequisite, consent of instructor. 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 development of black ghettos, the use of particular techniques in urban geographical research.

GEOG 698 Seminar in Cartography. (1-16)

GEOG 718 Seminar in the Geography of Europe and Africa. (3) First and second semesters Prerequisite, GEOG 410, 415 or consent of instructor. Analysis of special problems concerning the resources and development of Europe and Africa

GEOG 728 Seminar in the Geography of Europe and Africa. (3) First and second semesters Prerequisite, GEOG 410, 415 or consent of instructor. Analysis of special problems concerning the resources and development of Europe and Africa

GEOG 738 Seminar in the Geography of East Asia. (3) First and second semesters 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 739 Seminar in the Geography of East Asia. (3) First and second semesters. 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 Seminar in the Geography of Latin America. (3) First and second semesters. 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 749 Seminar in the Geography of Latin America. (3) First and second semesters. Prerequisite, GEOG 431, 432 or consent of instructor An analysis of recent charges and trends in industrial development, exploitation of mineral resources and land utilization.

GEOG 758 Seminar in the Geography of the U.S.S.R. (3) First and second semesters. 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 759 Seminar in the Geography of the U.S.S.R. (3) First and second semesters. 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) First and second semesters. 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 of 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. (1-9)

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 and theoretical and practical relationships between the internal and external properties of crystalline solids. Encompasses morphological, optical and chemical crystallography.

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.

GEOL 423 Optical Mineralogy. (3) (Offered 1972-73). 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.

GEOL 431 Invertebrate Paleontology. (4) Two lectures and one laboratory a week. Prerequisite, GEOL 102 or consent of instructor ZOOL 302 or equivalent recommended A systematic review of the morphology, classification, ecology, and geologic range of selected invertebrate groups represented in the fossil record

GEOL 432 Stratigraphic Paleontology. (3) (Offered 1973-74). Two lectures and one laboratory a week. Prerequisite, GEOL 431. Principles of biostratigraphy, paleoecology and paleogeography. Laboratory study emphasizes significant index fossils.

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 ostracoses and foraminifera.

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

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.

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.

GEOL 443 Petrology. (3) Prerequisite, GEOL 422 or consent of instructor. Two lectures and one laboratory per week. A detailed study of rocks: petrogenesis; distributions; chemical and mineralogical relation; macroscopic descriptions and geologic significance.

GEOL 444 Petrography. (3) One lecture 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.

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 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.

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 anomalies, 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) Two laboratories a week. Prerequisite, 422 or consent of instructor. A study of the geology of metallic ore deposits stressing ore-forming processes, configuration of important ore bodies, and familiarization with characteristic ore mineral suites.

GEOL 456 Engineering Geology. (3) Prerequisite, GEOL 441 or consent of the instructor. Two lectures and one laboratory a week. A study of the geological problems associated with the location of tunnels, bridges, dams and nuclear reactors, slope control, and natural hazards.

GEOL 460 Earth Science. (3) Two lectures and one laboratory a week. Prerequisite, permission of instructor. An interdisciplinary course designed to show how geology, meterology, physical geography, soil science, astronomy and oceanography are interrelated in the study of the earth and its environment in space. Recommended for science education.

GEOL 462 Geological Remote Sensing. (3) One lecture and two laboratories a week. Prerequisites, 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.

GEOL 489 Special Topics in Earth Science. (1-3) Prerequisite, GEOL 460 or equivalent.

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 or major interest.

Germanic Language and Literature Program

Professor and Chairman: Hering
Professors: Best, Dobert, Hinderer, Jones
Associate Professors: Fleck, Pfister
Assistant Professors: Elder, Irwin, Knoche

The Germanic Section of the Department of Germanic and Slavic Languages and Literatures offers programs of study leading to the M.A. and Ph.D. degrees. Specialization includes the following areas: Language Pedagogy and Applied Linguistics, Germanic Philology, Medieval Literature and Culture, Literature of the German Speaking Countries from the Renaissance to the Present.

In addition to the Graduate School requirements, candidates must have a bachelor's degree with an undergraduate major in German language and literature or the equivalent, and fluency in the written and spoken language. Candidates for the doctorate must have a master's degree in Germanic Studies or in a related discipline, for example: German, Scandinavian Studies, Language Education, Medieval Studies, etc.

Degree requirements for the M.A. (thesis option) are: 24 hours of coursework, the thesis, and a written comprehensive examination. The M.A. (non-thesis option) requires 30 hours of coursework, a mini-thesis with oral defense, and a written comprehensive examination. For both options the comprehensives consist of five two-hour examinations based on the coursework and the M.A. Reading List.

Degree requirements for the Ph.D. are as follows: 1) completion of at least 30 hours of coursework over a period of residency at the University of Maryland of at least one year, and a further 12 hours of dissertation research; 2) a reading skill examination in a language other than English or German related to the candidate's research or in a further Germanic language; 3) oral presentation of the dissertation topic to the Germanic Section graduate faculty before the topic is approved; 4) comprehensive written examinations; 5) the dissertation; 6) the oral dissertation defense. The doctoral comprehensives consist of seven three-hour examinations. The candidate has considerable freedom in choosing the subject to be covered in four of the examinations;—the other three being the required fields of philology or applied linguistics, medieval literature, and modern literature. Candidates who opt for all four selected topics in German literature will choose subjects in each of the following periods: 16th and 17th centuries, 18th century, 19th century, 20th century; in which case the required modern literature examination will require interpretation of a text. Candidates who select topics from other fields, such as philology, Scandinavian studies, medieval studies, etc., will take a general examination in the modern literature required exam.

In addition to its course offerings listed below, the Germanic Section of the Department of Germanic and Slavic Languages and Literatures sponsors the German Club, the University of Maryland Chapter of Delta Phi Alpha (the national German language honors society), and a Drama Reading Circle at which German plays are read by students with assigned roles and then discussed with faculty assistance. The Germanic Section also invites a distinguished scholar to join the staff for a semester every few years as guest professor. A series of guest lectures brings interesting speakers to the campus almost monthly. College Park's closeness to Washington, D.C. facilitates participation in the many cultural functions of the capital with its wealth of German and Scandinavian social groups and national societies.

The Germanic Section is able to contribute to the financial support of its graduate students in the form of teaching and non-teaching assistantships as well as several fellowships. Germanic Section graduate students are represented with two voting seats on the Department's Advisory Committee as well as by delegates to most of the other departmental committees, allowing them to take an active part in decisions which affect the Department in general and the graduate student in particular.

GERM 001 Elementary German for Graduate Students. (3) Intensive elementary course in the German language designed particularly for graduate students who wish to acquire a reading knowledge. This course does not carry credit towards any degree at the university.

GERM 400 Bibliography and Methods. (3) Introduction to the use of German bibliographies, catalogues, and reference books in order to locate both primary and secondary sources. Researching, composing, and documenting term papers and theses. Instruction in English.

GERM 431 Literature of the Middle Ages. (3) Prerequisite, GERM 321 and 322. German literature from the 9th through the 15th centuries in abridged modern German versions.

GERM 432 German Literature of the Baroque Period. (3) Prerequisite, GERM 321 and 322. Survey of Baroque literature as it developed from the Renaissance, Humanism, the Reformation.

GERM 441 Enlightment: Storm and Stress. (3) Prerequisites, GERM 321 and 322. Covers the time from Gottschedi's influence to Goethe's Italian journey (ca. 1720-1786). Shows the intellectual, ideological and literary influenced in enlightment and storm and stress.

GERM 442 Classicism. (3) Prerequisites, GERM 321 and 322. Covers the time from Goethe's Italian journey to Goethe's death (ca. 1786-1832). Intellectual, ideological and literary influences on the inner development and unity of this epoch.

GERM 451 Romanticism. (3) Prerequisites, Germ 321 and 322. Covers the main movements in German "Fruh-und Spatromantik," with reference to music, arts, science, and philosophy.

GERM 452 Realism. (3) Prerequisites, GERM 321 and 322. Representative figures of German Realism from Hebbel to Fontane.

GERM 461 Naturalism and its Counter Currents. (3) Prerequisites, GERM 321 and 322. Prose and dramatic writings from Gerhart Hauptmann to Expressionism. Modern literary and philosophical movements.

GERM 462 Expressionism to the Present. (3) Prerequisites, GERM 321 and 322. Prose and dramatic writings from Expressionism to present. Modern literary and philosophical movements.

GERM 469 Proseminar—Selected Topics in German Literature. (3) Specialized study of one great German writer or of relevant topics of literary criticism.

GERM 470 Structure of the German Language. (3) An introduction to applied linguistics suited to the needs of the advanced student and/or teacher of German. Structural analysis of the phonology, morphology and syntax of modern German in comparison with structure of modern English. Knowledge of German not required.

GERM 471 Introduction to Indo-European Philosophy. (3) Basic principles of historic language study. Reconstructed Indo-European surveys of the most important ancient Indo-European languages. No knowledge of German required.

GERM 472 Introduction to Germanic Philology. (3) Prerequisite, GERM 471 or permission of instructor. Reconstructed proto-Germanic, with surveys of Gothic, Old Norse, Old English, Old Saxon and Old High German. The high development of High German from the earliest documents to the modern dialects.

GERM 473 Reading Swedish, Danish and Norwegian. (3) Develops reading facility in three languages in one semester. Texts read include Bergman's *Seventh Seal*, tales by H.C. Andersen, excerpts works by Ibsen and Hamsun, and selected folk literature. No foreign language prerequisite.

GERM 474 Reading Swedish, Danish and Norwegian II. (3) Prerequisite, GERM 473 or permission of the instructor. Further development of reading facility.

GERM 479 Proseminar in Germanic Philology. (3) Prerequisite, consent of instructor. Selected topics such as comparative Germanic studies, Old Norse language or readings in Old Norse literature, modern German dialectology. Repeatable to a maximum of six credits if subject matter is different.

GERM 483 German Civilization (In English) I. (3) Literary, educational, artistic traditions; great men, customs and general culture.

GERM 484 German Civilization II. (3) Literary, educational, artistic traditions, great men, customs and general culture. A continuation of GERM 483.

GERM 488 German Literature in Translation. (3) Different movements, genres of other special topics will be discussed every semester. No knowledge of German

necessary. May not be counted in fulfillment of German major requirement. Repeatable to a maximum of six credits if subject matter is different.

GERM 489 Proseminar in Germanic Culture. (3) Selected topics in the cultural and intellectual history of the German and Germanic language areas. In English. Repeatable to a maximum of six credits if subject matter is different.

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., periphrastic 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 Middle High German. (3) Grammar and Readings in Middle High German literature.

GERM 606 Middle High German. (3) Grammar and readings in Middle High German literature.

GERM 611 College Teachings of German. (3) Instruction, demonstration and classroom practice under supervision of modern procedures in the presentation of elementary German courses to college age students.

GERM 711 Literature of the Sixteenth and Seventeenth Centuries. (3) Study of the Reformation, Humanism and the Baroque. The main works of Luther, Sachs, Wickram, Fischart, Opitz, Gryphius, Grimmelshausen.

GERM 712 Literature of the Sixteenth and Seventeenth Centuries. (3) Study of the Reformation, Humanism and the Baroque. The main works of Luther, Sachs, Wickram, Fischart, Opitz, Gryphius, Grimmelshausen.

GERM 745 Goethe and His Time. (3) The main works of Goethe and his contemporaries as reflecting the literary development from Rococo to Biedermeier.

GERM 746 Goethe and His Time. (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 001 Elementary Russian for Graduate Students. (3) Graduate Students should register as auditors only. Intensive elementary course in the Russian language designed particularly for graduate students who wish to acquire a reading knowledge. This course does not carry credit towards any degree at the university.

RUSS 401 Advanced Composition. (3)

RUSS 402 Advanced Composition. (3)

RUSS 421 Russian Civilization (In Russian) I. (3) An historical survey of Russian civilization, emphasizing architecture, painting, sculpture, music, ballet and the theater to the beginning of the 19th century pointing out the interrelationship of all with literary movements, taught in Russian.

RUSS 422 Russian Civilization (In Russian) II. (3) An historical survey of Russian civilization emphasizing architecture, painting, sculpture, music, ballet, and the theater, from the beginning of the 19th century to the present pointing out the inter-relationships of all with literary movements. Taught in Russian.

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.

RUSS 471 Comparative Slavic Linguistics. (3) Comparative Slavic linguistics and, especially, a concept of the place of the Russian language in the world of Slavic culture through the reading of selected texts illustrating common Slavic relationships and dissimilarities.

Government and Politics Program

Professor and Chairman: Bobrow
Professors: Anderson, Burdette, Dillon, Harrison, Hathorn, Hsueh, Jacobs, McNelly, Murphy, Piper, Plischke
Associate Professors: Claude, Conway, Devine, Glendening, Heisler, Koury, Ranald, Reeves, Stone, Terchek, Wilkenfeld, Wolfe
Assistant Professors: Bechtold, Butterworth, Chaples, Glass, Kapungu, Lanning, McCarrick, Melnick, Oliver, Strouse, Welin.
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 specialization.

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 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) Prefrequisite, 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 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, ser-

vice 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 to 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 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 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 political ideas in Russia and the Soviet Union from early times to the present.

GVPT 448 Non-Western Political Thought. (3) Political throught onginating 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 politics 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 illustrations 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 procedure 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 political 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 252 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 Agrican countries, with special emphasis on the problems of nation-building 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 600 Proseminar in Government and Politics. (3) Required of M.A. candidates. A Proseminar offering a survey of major concepts, approaches, and research trends in political science.

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 707 Relations-Comparative Systems. (3) A survey from Kautilya to Kaplan of the literature in IR theory with an emphasis on comparative historical systems.

GVPT 708 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. Repeatable to a maximum of 6 hours.

GVPT 710 Introduction To Graduate Study in Public Administration. (3) An examination of the history, background, and trends of public administration and the basic concepts and the approaches utilized in the organizational process of public bureaucracies. Readings from textual sources will include the following: the study of public administration, the societal and political environment, organization theory and behavior, administrative law, comparative and development administration, policy and systems analysis, program planning and budgeting, manpower resources development, organizational performance and accountability.

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 individual 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 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, national, 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 827 Seminar in Political Sociology. (3) Prerequisite, GVPT 427 or equivalent. Inquiries into the conceptual and theoretical foundations of and empirical data in the field of political sociology. Individual readings and research problems will be assigned. Dealing with the social contexts of politics and the political aspects of social relationships.

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 men 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) Prerequitite, 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. An examination of problems in the relations of states involving the Soviet Union.

GVPT 852 Area Problems in International Relations—Latin America. 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 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 various 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. 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
Professor: Johnson, Leviton
Associate Professors: Da. Girdano, Do. Girdano, Miller, Tift
Assistant Professors: Althoff, Clearwater, Needle, Stone

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 this 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 physical education and health.

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) This is 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) Prerequisites, HLTH 105 or 140; 310. This course, designed for the elementary school classroom 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 471 Women's Health. (3) The women's health movement from the perspective of consumerism and feminism. Ths physician-patient relationship in the gynecological and other medical settings. The gynecological exam, gynecological problems, contraception, abortion, pregnancy, breast and cervical cancer and surgical procedures. Psychological aspects of gynecological concerns.

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 multi-disciplinary 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 487 Adults Health and Developmental Programs for the Aged. (3) Prerequisite, at least junior standing in health and special permission of the instructor. Training and experience in a clinically oriented development program for the aged.

HLTH 488 Children's Physical Developmental 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. Repeatable to a maximum of 4 hours.

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 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) Prerequisite, HLTH 456 or permission of the instructor. The advanced study and investigation of human dying, bereavement, 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 730 Problems in Weight Control. (3) Prerequisite, HLTH 720 or permission of instructor. A study of the causes, health cost, and control of obesity through analysis of lipid-glucose interaction; hunger-satiety theories and mechanisms; psycho-social forces in obesity; body composition. Energy output; and disease states related to obesity.

HLTH 740 Modern Theories of Health. (3)

HLTH 750 Stress and Disease. (3) A study of the causative agents of chronic disease with particular emphasis on stress including the physiological response of the human organism to contemporary psycho-social stressors and mechanisms of adaptation and prophylaxis.

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, Bernthal, Doudna, Hamlet, Kumin, Weiner
Lecturer: Spuehler
Research Professor: Causey
Research Associate Professor: Elkins
Research Assistant Professor: 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 M.A. program usually requires three semesters and a summer session to complete. Only full-time students are admitted to the program.

The department also offers the Ph.D. degree with major emphasis in speech and language pathology, speech science, or hearing science. Ordinarily a Master's degree is required for admission to the doctoral program. 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. Qualifying interviews are scheduled for each candidate after completion of 12 semester hours in the program. Written and oral comprehensive examinations for admission to candidacy are scheduled at the completion of the formal course program.

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.

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. The department is able to provide some financial support in the form of teaching or clinical assistantships or traineeships to approximately 40 percent of the graduate students enrolled. 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.

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.

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.

HESP 411 Introduction to Audiology. (3) Prerequisites, HESP 202. Physics of sound, anatomy and physiology of hearing, introduction to measurement and to rehabilitation of the hearing-handicapped.

HESP 412 Rehabilitation of the Hearing Handicapped. (3) Prerequisite, HESP 314. Speech reading, 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 499 Independent Study. (1-3) Prerequisite, departmental approval. May be repeated for a maximum of 6 credits.

HESP 604 Acoustical and Perceptual Phonetics. (3) Laboratory techniques in analysis of the acoustical and perceptual characteristics of the speech signal.

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.

HESP 610 Aphasia. (3) Language Problems of Adults Associated with Brain Injury.

HESP 612 Stuttering. (3)

HESP 614 Orofacial Anomalies. (3)

HESP 616 Language Disorders of Children. (3)

HESP 620 Articulation Disorders. (3)

HESP 622 Neuromotor Disorders of Speech. (3)

HESP 624 Voice Disorders. (3)

HESP 626 Differential Diagnosis of Nonverbal Children. (3) Evaluation of the nonverbal child.

HESP 634 Medical Aspects of Speech and Hearing Disorders. (1-3) Lectures by physicians on embryological, anatomical, physiological, and neurological bases of speech and hearing disorders.

HESP 638 Minor Research Problems. (1-3) Special projects in hearing and speech science. Repeatable for a maximum of 6 credits.

HESP 640 Advanced Principles of Hearing and Speech Therapy. (3) Analysis of the clinical process with emphasis on the application of learning theory to treatment of speech disorders

HESP 642 Neurophysiology of Hearing. (3) Processing of stimuli by the auditory nervous system

NESP 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.

HESP 702 Diagnostic Procedures in Speech Pathology. (3) Diagnostic tools and methods in the analysis of various types of speech disorders. Practicum required.

HESP 704 Physiological Phonetics. (3) Prerequisite, HESP 604. Laboratory techniques in the study of the speech mechanism.

HESP 706 Advanced Clinical Audiology. (3) Prerequisite, HESP 606 or equivalent. Techniques for evaluation of children and adults presenting special diagnostic problems.

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.

HESP 724 Quantitative Methods in Hearing and Speech Science. (3) Prerequisite, course in basic statistics. Analysis of current procedures used in quantifying phenomena observed in hearing and speech science.

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.

HESP 806 Administration of Hearing and Speech Programs. (3) Problems of staffing, budgeting, and operating training and clinical service programs.

HESP 810 Experimental Design in Hearing and Speech Science. (3) Prerequisite, HESP 724 or permission of instructor. Design and evaluation of research projects. Preparation for undertaking the doctoral dissertation.

HESP 820 Bioacoustics. (3) Prerequisite permission of instructor. Functioning of the hearing mechanism in animals and humans. Laboratory research methods.

HESP 822 Psychoacoustics. (3) Prerequisite, permission of instructor. Study of human response to acoustic stimulation.

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.

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: Callcott, Carter, Cole, Duffy, Foust, Gilbert, Gordon, Haber, Harlan, Jashemski, Kent, Merill, A. Olson, Prange, Smith, Sparks
Associate Professors: Belz, Berry, Breslow, Brush, Cockburn, Farrell, Flack, Folson, Hoffman, Giffin, Greenberg, Kaufman, Grimsted, Mayo, Olson, Schuessler, Shoufani, Stowasser, Warren, Yaney
Assistant Professors: Bradbury, Harris, Holum, Lampe, Majeska, Matossian, McCusker, Nicklason, Perinbam, Ridgway, Spiegel, 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: United States, Ancient Medieval, Early Modern European, Modern European, British, Russian, Latin American, African, Middle Eastern, East Asian, Diplomatic, and Science and Technology. (The aptitude parts of the GRE are required.)

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, (the aptitude parts of the GRE are required); it should be noted that an undergraduate major in history is not as such required for admission. Of the thirty credit hours required 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; two 800-level research-writing seminars are required. 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 adivsory 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.

An 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.

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, the physicial 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 HIST 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 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.

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)

History, Foreign

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) Prerequisites, 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 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 History of European Ideas. (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.

HIFN 415 History of European Ideas. (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. 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) An analysis of the development of the British Empire since the American Revolution. Particular emphasis is given to the problem of responsible self-government, the evolution of the British Empire into a commonwealth of nations and the problems of the dependent empire. Recommended prerequisites, HIST 112, 113, 141, or 254.

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 to 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 to 1801. (3) A history of Russia from earliest times to 1917.

HIFN 425 History of Russia from 1801-1917. (3) A history of Russia from earliest times to 1917.

HIFN 426 Europe in the Nineteenth Century, 1815-1919. (3) A study of the political, economic, social, and cultural development of Europe from the Congress of Vienna through the First World War. Recommended prerequisites, HIST 113, 114, or 254.

HIFN 430 Europe in the World Setting of the Twentieth Century. (3) Recommended prerequisites, HIST 113, 142, or 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 (Students enrolled in HIFN 430 and 431 previous to fall, 1974, not admitted).

HIFN 432 The Soviet Union. (3) A history of Soviet Russia and the Soviet Union from 1917 to the present. Stress on the relationship between Marxist theory and practice, and the development of peculiarly socialist institutions and practices.

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 438 Introductory Middle Eastern Languages I. (3) Prerequisite, consent of the department. An introduction to the three principal languages of the Islamic Middle East—Arabic, Persian, and Turkish. Only standard written form of the three languages is taught. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanities language requirement.

HIFN 439 Introductory Middle Eastern Languages II. (3) Prerequisite, HIFN 438 and consent of the department. Continuation of HIFN 438. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanities language requirement

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 Absolutism, 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 Intermediate Middle Eastern Languages I. (3) Prerequisite, HIFN 439 and consent of the department. Continuation of HIFN 439. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanities language requirement.

HIFN 449 Intermediate Middle Eastern Languages II. (3) Prerequisite, HIFN 448 and consent of the department. Continuation of HIFN 448. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanities language requirement.

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 an 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 Greece. (3) Greek history and culture from the bronze age to 200 B.C. Concentration on the life and institutions of the city-state, poetry and society, the Peloponeesian war, and Alexander the Great

HIFN 457 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. Students previously enrolled in HIFN 410 not admitted

HIFN 458 Advanced Middle Eastern Languages I. (3) Prerequisite, HIFN 449 or equivalent and consent of the department. Continuation of HIFN 449. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanties language requirement

HIFN 459 Advanced Middle Eastern Languages II. (3) Prerequisite, HIFN 458 and consent of the department. Continuation of HIFN 458. May be repeated to a maximum of nine hours when language varies. May not be used to satisfy arts and humanities language requirement

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

HIFN 462 Germany in the Nineteenth Century, 1819-1914. (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, anyone 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 to 1750. (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 Since 1750. (3) Causes and consequences of industrial development in Western and Eastern Europe

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 834 Seminar in the Social and Cultural History of Europe. (3) Research methods for multi-generational family history, the comparative study of folk cultures, and the study of creative minorities. Includes a general introduction to research in European society and culture.

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 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 in 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.

History, United States

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, 1783-1824. (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 408 Topics in United States Social History. (3) A consideration of selected aspects of American society from Colonial times to the present. Special emphasis given to regionalism, immigration, nativism, minorities, urbanization, and social responses to technological changes. Since emphasis on topics may change from semester to semester, course may be repeated to a maximum of six credits if topics are different.

HIUS 410 The Middle Period of American History, 1824-1850. (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) A detailed study of historical interpretations; the political, economic, social, and psychological forces which caused the war; and the process and impact of the war itself.

HIUS 412 Reconstruction and the New Nation, 1869-1896. (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.

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 History of the South. (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 421 History of the South. (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 permission of instructor.

HIUS 424 The History of Ideas in America. (3) A history of basic beliefs about religion, man, nature, and society.

HIUS 425 The History of Ideas in America. (3) A history of basic beliefs about religion, man, nature, and society.

HIUS 426 Constitutional History of the United States. (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 427 Constitutional History of the United States. (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 History of the American Frontier. (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 434 History of the American Frontier. (3) Exploration, settlement and development of the trans-Mississippi 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 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 732 Readings in American Labor History. (3) Social and cultural history of the American working class with special attention to communities based on ethnicity, race, sex, residence and ideology; history of the labor movement; selected comparisons with working-class communities of other countries.

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 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 832 Seminar in American Labor History. (3) Advanced research and writing on selected topics in the history of American workers, their conditions, communities, organizations and ideas.

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 Acting Chairman: Twigg
Professors: Kramer, Link, Reynolds, Scott (Emeritus), Shanks, Stark, Thompson, Wiley.
Associate Professors: Angell, Baker, Bouwkamp, Schales
Assistant Professors: Beste
Lecturer: Koch (Visiting)

The Department of Horticulture offers graduate study leading to the Master of Science and Doctor of Philosophy degrees. The Master of Science degree is offered with both thesis and non-thesis options. Candidates place major emphasis in the areas of pomology, olericulture, floriculture, or ornamental horticulture. Within these commodity areas, students may direct their studies and research efforts to mineral nutrition, postharvest physiology, plant breeding, chemical growth regulation, water relations, plant propagation, histochemistry, photoperiodism and environmental control, and other factors affecting production of horticultural plants. The candidate's program may be directed toward a career in research, teaching, extension education, or industry. The research activities required for the thesis or dissertation are normally carried out in conjunction with the research programs of the departmental staff.

Modern laboratory and greenhouse facilities are located at the College Park campus. Laboratory instrumentation provides for chromatography, spectrometry, elemental analysis, histology, and other procedures. A system for automatically monitoring respiratory gases and volatiles is available in connection with controlled atmosphere chambers. Controlled-temperature storages and a bank of growth chambers provide facilities for postharvest and environmental control studies. Adequate greenhouse and plot areas are available for research with floricultural and ornamental plants. Orchards for research with fruits are located at the Plant Research Farm 7 miles from the campus. Other research studies are conducted cooperatively with fruit growers in the western part of the state. Field research wtih vegetable crops is carried on at the Vegetable Research Farm, Salisbury, and with ornamental and vegetable crops at Chester-on-Wye near Grasonville. The Beltsville Research Center of the United States Department of Agriculture is located 3 miles from the campus. Students have the opportunity to attend seminars at the Research Center, to take specialized courses of the USDA graduate school and, in certain cases, to conduct research projects in cooperation with the personnel at the USDA Research Center. In addition to library facilities at the University, the National Agricultural Library is now relocated at the Research Center, readily available to graduate students of the University.

Students entering with a B.S. degree in Horticulture can normally complete all requirements for the M.S. in 2 years on a half-time basis, 4 years for the Ph.D. Full-time students should complete the requirements in a shorter time. Students seeking admission should present undergraduate preparation in horticulture, botany, chemistry, and supporting agricultural disciplines. Those without this background are advised to enroll as special undergraduate students to correct these deficiencies. The Graduate Record Examination is not required.

Students entering the doctoral program should have, or plan on completing, a Master of Science degree in Horticulture, although presentation of the M.S. in a related plant science field may be acceptable.

Upon admission, the student is assigned to a faculty advisor, and an advisory committee is appointed. It is an early function of the committee to work with the candidate in developing a program of courses and research, tailor-made to the goals and aspirations of the student. The Department requires no foreign language proficiency. A comprehensive, oral examination is given each candidate for the M.S.; candidates for the Ph.D. take an oral qualifying examination, as well as an oral comprehensive examination covering the dissertation.

Some graduate students are supported with financial aid. Research and teaching assistantships are offered to students on full admission status, as available. All graduate assistants are expected to assist in the teaching program of the Department.

HORT 411 Technology of Fruits. (3) Three lectures per week. Prerequisite, HORT 112, 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.

HORT 417 Tree and Small Fruit Mangement. (1) 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.

HORT 427 Truck Crop Mangement. (1) 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.

HORT 453 Woody Plant Materials. (3) Prerequisite, BOTN 212. A field and laboratory study of trees, shrubs, and vines used in ornamental plantings.

HORT 454 Woody Plant Materials. (3) Prerequisite, BOTN 212. A field and laboratory study of trees, shrubs, and vines used in ornamental plantings.

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.

HORT 457 Ornamental Horticulture. (1) 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.

HORT 682 Methods of Horticultural Research. (3) Second semester. One lecture and one four-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) First and second semester. Credit according to time scheduled and organization of the course. Organized as a lecture series on a specialized advanced topic.

HORT 699 Special Problems in Horticulture. (1-3) First and second semester. 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) First semester, alternate years 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.

HORT 782 Chemical Regulation of Growth of Horticultural Plants. (3) Second semester, alternate years. 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 potentials for future research.

HORT 783 Environmental Factors and Horticultural Plants. (3) First semester, alternate years 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 condidtions will be considered.

HORT 784 Current Advances in Plant Breeding. (3) Second semester, alternate years. 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.

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

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) Eight hours studio periods. Prerequisite, HSAD 440. Preparation of complete presentation: work specifications, floor plans, purchase orders, renderings, etc. Portfolio preparation.

HSAD 442 Readings in Housing. (3) Seminar. Prerequisites, SOCY 100, HSAD 241, senior standing. To satisfy individual interests and needs, opportunity 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.

CRAF 438 Individual Problems in Metalry. (3) Prerequisites, CRAF 230, 330, 430 with at least a grade of B in all three courses. 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 448 Individual Problems in Textile Design. (3) Prerequisites, CRAF 240, 241, 340, or 341 with at least a grade of B in all three courses. Open to students with demonstrated ability and with the potential for a high level of achievement on studio production or in research. Total undergraduate credit permitted in all individual problems courses in crafts as a maximum of nine hours. Consent of crafts faculty. No less than B average on prerequisites and presentation of work evaluation.

Human Development Education Program (Institute for Child Study)

Professor and Director: Morgan
Professors: Chapin, Dittmann, Goering, Kurtz, Perkins
Associate Professors: Eliot, Flatter, Gardner, Hardy, Hatfield, Huebner, Kyle, Matteson, Milhollan, Rogolsky
Assistant Professors: Ansello, Bennett, Davidson, Green, Hunt, Koopman, Marcus, Shifflett, Svoboda, 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 degrees 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 the 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 for 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, school, 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.

EDHD 416 Scientific Concepts in Human Development III. (3) Guided reading and observation of pupils throughout the school year. Emphasis on human developments 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 on 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.

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.

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. 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 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 of 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 half-day 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.

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 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.

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 or 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.

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.

EDHD 613 Advanced Laboratory in Behavior Analysis I. (3) First of a three-hour sequence in

the study of behavior. Analysis focuses upon the major forces which shape the development and learning of children and youth. Summer session only

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 behavioral 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 6 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.

EDHD 710 Affectional Relationships 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.

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.

EDHD 721 Learning Theory and The Educative Process I. Provides a systematic review of the major theories and their impact on education. Considers factors that influence learning.

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.

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 workshop D, consultants in 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.

EDHD 731 Field Program in Child Study II. (3) Prerequisite, EDHD 730 or consent of instructor. Offers advanced training and apprenticeship preparing 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.

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.

EDHD 799 Master's Thesis Research. (1-6) Registration required to the extent of six hours 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 serve 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 in 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. The personality theories of Freud, Jung, Adler, Horney, Fromm, Sullivan, Murray, Lewin, and Allport.

EDHD 831 Self Processes in Human Development II. (3) Prerequisite, EDHD 830 or consent of instructor. The personality theories or Erickson, 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 process 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 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 EDHD 489, 888 and 889 is limited to a maximum of twenty (20) semester hours.

EDHD 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 for 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) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Industrial Education Program

Associate Profess and Acting Chairman: Maley
Professors: Harrison, Hornbake, Luetkemeyer
Associate Professors: Anderson, Beatty, Mietus, Stoush, Tierney
Assistant Professors: Burkart, Elkins, 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.—thesis required, and M Ed.—non-thesis option) 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, including types of programs, their organization, development, and evaluation.

EDIN 426 Industrial Training in Industry II. (3) Prerequisite, EDIN 425. Studies of 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 Occupational 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, distribution 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 determinating 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)

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 industrial 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) Registration required to the extent of 6 hours 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 or 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) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours 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 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; IFSM 402, BSAD 231, 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 anlysis 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 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 430, dealing with multivariate models. Prerequisites may be waived with the consent of the instructor. Implementation of applications requiring the integration of data processing and 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 forecasting 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 435 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 Equipment. (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-detecting and software considerations. Data communicating devices, including the functional characteristics of longline, telephone channel, transceiver and communication satellites, case studies and examples.

Journalism Program

Professor and Dean: Hiebert
Professors: Bryan, Crowell, Martin, Newsom
Associate Professors: Grunig, Sommer
Assistant Professors: Hesse, Hoyt, 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 journalism background, adding in-depth work in a substantive minor field, as preparation for a career in a specialized area of mass communication. 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 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. Students who have majored in some other field as undergraduates are required to make up professional deficiencies by taking four or five selected courses in journalism without graduate credit. 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 up 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 Washington Star-News*, 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 clipping and bulletin files.

JOUR 400 Law of Mass Communication. (3) Study 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 media 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) Prerequisites: JOUR 200 and 201. 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.

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 Professional Seminar. (3) Prerequisites—JOUR 200, JOUR 201 and consent of instructor. Projects and discussions relating professional work experience to the study of journalism. Limited to students who participated in an approved summer work experience after the junior year.

JOUR 499 Independent Study. (1-3) Individual projects in journalism. May be repeated to a maximum of three hours.

JOUR 600 Research Methods in Mass Communication. (3)

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)

JOUR 620 Seminar in Public Affairs Reporting. (3)

JOUR 621 Interpretation of Contemporary Affairs. (3)

JOUR 630 Seminar in Corporate Communication. (3)

JOUR 640 Mass Culture and Mass Communication. (3)

JOUR 700 Seminar in Mass Media Law. (3)

JOUR 710 Seminar in Mass Media History. (3)

JOUR 720 Seminar in Government and Mass Communication. (3)

JOUR 721 Seminar in Urban Mass Communication. (3)

JOUR 730 Seminar in Comparative Mass Communication. (3)

JOUR 731 Cross-Cultural Communication. (3)

JOUR 799 Master's Thesis Research. (1-6)

JOUR 800 Seminar in Critical Analysis. (3)

JOUR 810 Special Problems in Communication. (3)

JOUR 812 Seminar in Communication Theories. (3)

Library and Information Services Program

Acting Dean: Dubester

Professors: Bundy, Heilprin,[1] Kidd, Liesener, Olson, Reynolds, Wasserman

Associate Professor: Soergel

Assistant Professors: Bates, Kraft, Lukenbill, MacLeod, Mendiville

[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.

Admission as a student to the College is limited to individuals who hold the bachelor's degree from recognized colleges, universities or professional schools in this country or abroad or to those who can give evidence of successful completion of equivalent courses of study. The individual's undergraduate academic record is of primary importance as an indicator of his competence to pursue graduate study in librarianship, but other factors are also taken in account in reviewing applications. The potential student's performance in the verbal and quantitative tests of the Graduate Record Examination administered by the Educational Testing Service of Princeton, New Jersey, and letter of personal recommendation and information gained from personal interviews with potential students are considered. Reports relating to the applicant's intellectual and personal development as an undergraduate are sometimes considered, as are such factors as employment experience, military service and other related activities when they appear to be relevant in a particular case as part of the admissions review process. All these factors are considered significant in assessing the applicant's capacity and motivation for graduate work in the College and for his later performance as a responsible member of the library profession. The Admissions Committee will consider exceptions to and waiver of requirements in some cases.

Although no specific undergraudate 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 pro-seminar 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 multidisciplinary 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 of 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.

A substantial number of fellowships and assistantships are available for students enrolled in the College. Loan funds administered by the University and federally insured loans are also available. Public libraries in the region as well as other local organizations offer a few stipends and scholarships. In addition a student in the College is eligible to apply for scholarships, fellowships and grants from national organizations awarded for graduate study in librarianship. Information on the availability of such

awards may be requested from the Director of Admissions.

The Ph.D. program requires the equivalent of three years of full-time work, normally divided into approximately two years of formal course-work (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. (3-6) 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 Information Services. (3) Information and reference systems, services, and tools provided in libraries and information centers. Problems and concepts of communication, question negotiation, bibliographic control, and search processes are considered. Major types of information sources and modes of information delivery are introduced.

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 641 Selection and Evaluation of Instructional Media. (3) Development of criteria for selection and evaluation of instructional materials for classroom, school and system use; includes measures of readability, listenability, visual difficulty and interest level.

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 information, and in the procedures used in their evaluation.

LBSC 665 Problems of Nonbook Materials. (3) Examination of nonbook materials such as audiorecords, motion pictures, maps, videorecords, machine-readable data files, and realia. Technical services applicable to nonbook materials.

LBSC 670 Seminar in Technical Services. (3) Special issues in technical services in large libraries. Deals with such areas as exquisitions, 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 material 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 to 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 of 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 subfields of contemporary library and information developments.

LBSC 740 Seminar in Library and Information Networks. (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 Service 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 434.

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 SPHR 604.

Mathematics Program

Professor and Chairman: Goldhaber

Professors: Adams, Antman, Auslander, Benedetto, Brace, Chu, Correl, Douglis, Ehrlich, Edmundson,[1] Goldberg, Goldstein, Good, Gray, L. Greenberg, Gulick, Horvath, Hummel, Jackson, Kirwan, Kleppner, Kubota, Lehner, Lipsman, Lopez-Escobar, Maltese, Mikulski, Ortega,[1] Pearl, Reinhart, Rheinboldt,[1] Schaefer, Stellmacher, Strauss, Syski, Vesentini, Zalcman, Zedek

Associate Professors: Alexander, Anderson, Berg, Bernstein, Cook, Cooper, Dancis, Ellis, Fey,[2] Green, Helzer, Henkelman,[2] Johnson, Lay, Markley, Neri, Osborn, Owings, Sather, Schafer, Schneider, Warner, Wolfe, Yang

Assistant Professors: Berstein, Currier, Davidson,[2] Fay, R. Greenberg, Halperin, Harris, Hill, Kueker, Lee, Liu, Mucci, Nagarsenker, Niebur, Powell, Razar, Schmidt, Smith, Sweet, Winkelnkemper

[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 (Applied Mathematics), and Probability and Statistics. Admission is granted to applicants who evince marked ability and promise in mathematics as demonstrated by performance in collegiate mathematics. Although the Graduate Record Examination in Mathematics is not required for admission, applicants who have taken this examination are requested to supply their score in their application for admission.

The M.A. degree can be earned by either a thesis or non-thesis option but the great majority of students are exercising the latter. For this option a student must have 30 credit hours with grades of B or better in courses carrying graduate credit of which at least 18 are at the 600/700 level. Of these, in turn, 12 hours must be in mathematics. He must have taken two full-year sequences at the 600/700 level and he must have passed written examinations in three mathematical fields.

The student may take the Ph.D. examination and be scored at a lower level or he may take a special M.A. examination; the examination can be repeated once. There is no language requirement for the M.A. degree. About 30-35 M.A.'s are earned each year in mathematics.

At Maryland the M.A. degree is not required to enter the Ph.D. program. Here again the Ph.D. aspirant must take a set of three examinations in three separate fields of mathematics which can be repeated once. If successful, the student must satisfy the particular requirements of the field committee in his special area of interest before he will be permitted to engage in thesis research. Satisfaction of these requirements plus the tested ability to translate into English mathematical material in one of French, German, or Russian are conditions for admission to candidacy for the Ph.D. The dissertation must represent an original contribution to mathematical knowledge and will usually be published in a mathematical journal. Before the final oral examination on the dissertation can be scheduled the candidate must pass a second language examination, translating mathematical French,

German, or Russian into English so that he will be proficient in reading technical material in two foreign languages.

The average Ph.D. student will probably spend five years of graduate study to obtain his degree. From 10 to 15 Ph.D.'s are granted each year in the Department of Mathematics.

The Department is able to offer graduate assistantships to 40-50 percent of its graduate students; the number for 1974-75 was about 110. With very few exceptions these graduate assistants conduct discussion and quiz sections associated with a large lecture class taught by a faculty member; the teaching load is usually six hours a semester. In addition they are required to assist at registration time and to proctor the graduate written examinations. Renewals of assistantships are made by the Graduate Committee of the Department early in the spring semester on the basis of well-defined guidelines.

The number of fellows is small and their funding, being largely dependent on outside sources, is uncertain. There are, however, a few dissertation fellowships with a very modest stipend that are occasionally available for Ph.D. candidates who are in the late stages of writing their dissertations.

The facilities for graduate study and research are excellent. The Engineering and Physical Sciences library is located on the ground floor of the Mathematics Building and contains more than 95,000 volumes in mathematics, physics, and engineering; more than 280 journals in pure and applied mathematics are received. The Library of Congress with its extensive collection of books and technical reports is only a half hour away from the campus.

The Department cooperates closely with the Institute for Fluid Dynamics and Applied Mathematics and with the Department of Computer Science. Faculty members of both these centers offer courses in the Department of Mathematics and the facilities of the computer center are available to serve the research needs of both faculty and graduate students.

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 Albegra. (3) Prerequisite, MATH 400, or MATH 240, or consent of 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 straightedge 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 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 4109 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 and 463).

MATH 414 Differential Equations. (3) Prerequisite, MATH 240 and MATH 410, 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. Topics will include one dimensional wave equation; linear second order equations in two variables, separations of variables and Fourier series; Sturm-Liouville theory. (Credit will be given for only one course, MATH 415 or MATH 462).

MATH 416 Introduction to Real Variables. (3) Prerequisite, MATH 410. The Lebesgue integral. Fubini's theorem. The LP spaces. Convergence theorems.

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 developments 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, Konig'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 Godel 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 posfulates; algebraic structures associated with the construction; Archimedean order, sequential completeness and equivalent properties of ordered fields. Finite and infinite sets, denumberable and non-denumberable sets.

MATH 460 Computational Methods. (3) Prerequisite, MATH 241 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. (Credit will be given for only one course, MATH/CMSC 470 or MATH/CMSC 460.) (Listed also as CMSC 460)

MATH 462 Linear Analysis for Scientists and Engineers. (3) Prerequisites, MATH 241 and some knowledge of differential equations. Linear spaces and operators, orthogonality, Sturm-Liouville problems and Eigenfunction expansions for ordinary differential equations, introduction to partial differential equations, boundary and initial value problems. (Credit will be given for only one course, MATH 462 or MATH 415.)

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 Transform Methods for Scientists and Engineers. (3) Prerequisites, MATH 264, and either MATH 463 or MATH 413. Fourier series, Fourier and LaPlace transforms. Evaluation of the complex inversion 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 477 Optimization. (3) Prerequisite, CMSC 110 and MATH 409 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 student's appreciation of mathematics as 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. (1-16) 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 condition, homological algebra.

MATH 602 Homological Algebra. (3) Prerequisite, MATH 600. Projective and injective modules, homological dimensions, derived functors, 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 Nipotent groups, groups with operators, groups with local properties, groups with clan conditions, extensions.

MATH 606 Algebraic Geometry I. (3) Prerequisite, MATH 600-601 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 albegraic integers, algebraic number fields of finite degree, ideals and units, fundamental theorem 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, decomposition 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 411 or equivalent. Elementary set theory, elementary topological notions (especially for Euclidean space), Lebesgue measure and the Lebesgue integral on N, differentiation and integration of functions, absolute continuity, metric spaces, completeness and the Baire category theorem, LP spaces over N.

MATH 631 Real Analysis II. (3) Prerequisite, MATH 630. Locally compact Hausdorff spaces, Stone-Weierstrass theorem, general measure theory, Radon-Nikodym theorem, Riesz representation theorem, introduction to Banach and Hilbert spaces, Hahn-Banach theorem, closed graph theorem, Alaoglu's theorem.

MATH 632 Functional Analysis I. (3) Prerequisite, MATH 631. Introduction to linear functional analysis and operator theory, normed linear spaces, spectral theory of bounded and unbounded self-adjoint operators, applications to differential equations, notions of duality and convexity, additional topics as time permits, e.g., locally convex spaces, distribution theory, perturbation theory Note: MATH 632 and 633 are independent of one another and can be taken simultaneously.

MATH 633 Functional Analysis II. (3) Prerequisite, MATH 631. Introduction to abstract harmonic analysis, theory of Banach algebras, maximal ideal space, Gelf and Naimark theorem, locally compact groups, Fourier analysis on Abelian groups, Peter-Weyl theorem, group representations, additional

topics as time permits, e.g., function algebras, C^*-algebras, spectral synthesis, transformation groups. Note. MATH 632 and 633 are independent of one another and can be taken simultaneously

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 non-commutative 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) Prerequisites, 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 Classical Methods in Partial Differential Equations I. (3) Prerequisite, MATH 410 or equivalent. Cauchy problem for the wave equation and heat equation, Dirichlet and Neumann problem for LaPlace's equation. Classification of equations, Cauchy-Kowaleski theorem. General second order linear and nonlinear elliptic and parabolic equations.

MATH 674 Classical Methods in Partial Differential Equations II. (3) Prerequisite, MATH 673. General theory of first order partial differential equations, characteristics, complete integrals, Hamilton-Jacobi theory. Hyperbolic systems in two independent variables, existence and uniqueness, shock waves, applications to compressible flow.

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) Prerequisite, MATH 405 and 410 or equivalent. Operational methods applied to ordinary differential equations. Introduction to linear spaces, compact operators in Hilbert space, study of Eigenvalues.

MATH 681 Eigenvalue and Boundary Value Problems II. (3) Prerequisite, MATH 680. Boundary value problems for linear partial differential equations. Method of energy integrals applied to LaPlace's equation, heat equations and the wave equations. Study of Eigenvalues.

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. (Listed also 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 or 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. Devoted to the foundations of mathematics, including mathematical logic, axiom systems, and set theory.

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 constructability and regularity. Godel'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, Godel'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, Godel'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 theorem, 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 subjects, 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) Prerequisites, MATH 410, 411, 403 or equivalents. Point set topology; fundamental group and covering spaces; introductory material on differentiable manifolds.

MATH 731 Topology II. (3) Prerequisite, MATH 730. Simplicial complexes; differential forms, homology theory and De Rham theorem; classification of two manifolds.

MATH 734 Algebraic Topology I. (3) Prerequisite, MATH 731. Singular homology, uniqueness theorems, tensor products and homomorphisms, the functions EXT and TOR. Universal coefficient theorems, Kunneth and Eilenberg-Zilber theorems, products and duality.

MATH 735 Algebraic Topology II. (3) Prerequisite, MATH 734. Higher homotopy groups, CW complexes, obstruction theory, Eilenberg-Maclane 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. Diffentiable manifolds, embeddings in Euclidean space, vector and tensor bundles, vector fields, diffentiable 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) Prerequisites, MATH 141 or 221. Random variables, standard distributions, moments, law of large numbers and central limit theorem. Sampling methods, estimation of parameters, testing of hypotheses.

STAT 401 Applied Probability and Statistics II. (3) Prerequisite, STAT 400. Point estimation—sufficient, unbiased, and consistent estimators. Interval estimation. Minimum variance and maximum likelihood estimators. Testing of hypotheses. Regression correlation and analysis of variance. Sampling distributions. Sequential tests, elements of non-parametric 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 250 or 400 or equivalent. 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.

STAT 420 Introduction to Statistics. (3) Prerequisite, STAT 410 or equivalent. Point estimation, sufficiency, completeness, Cramer-Rao inequality, maximum likelihood. Confidence intervals for parameters of normal distribution. Hypotheses testing, most powerful tests, likelihood ratio tests. Chi-square tests, analysis of variance, regression, correlation. Non-parametric methods.

STAT 421 Elements of Statistical Inference. (3) Prerequisite, STAT 420 or equivalent. Rank tests, confidence and tolerance intervals, Kolmogorov-Smirnov tests. Sequential analysis, multivariate analysis. Decision theory, Bayesian and minimax procedures. Sampling theory.

STAT 450 Regression and Variance Analysis. (3) Prerequisite, STAT 401 or 420. One, two, three and four 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. Wilcoxin tests for paired comparisons.

STAT 477 Optimization. (3) Prerequisite, CMSC 100 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 498 Selected Topics in Statistics. (1-6) Prerequisite, permission of the instructor. Topics of special interest to advanced undergraduate students will be offered occasionally under the general guidance of the MATH/STAT major committee. Students register for reading in statistics under this number. Repeatable to a maximum of 16 credits.

STAT 600 Probability Theory I. (3) Prerequisite, STAT 410 or MATH 400 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, Lebesque integration, LP 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. Characteristic functions. Bochner's representation theorem.

Helly's theorems and Levy's inversion formula. Applications of Cauchy's residue theorem. Infinitely divisible distributions. Kolmogorov's three-series theorem. Lab of the iterated logarithm. Arc sine law. Central limit theorems (Lindegerg-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 sample continuity of stochastic processes. Stopping times. Martingales: fundamental inequalities, convergence theorems and their applications, optional sampling, Riesz decomposition, 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, standard processes. Markovian semi-groups, extended infinitesimal operator. Sample function behavior. Connections between semigroup approach and sample function approach. Diffusion theory, ITO equation, potential theory, Fine topology.

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 processes. 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 equivalent. Sampling distributions including noncentral Chi-square, T, F. Exponential families, completeness. Sufficiency, factorization, likelihood ratio. Decision theory, Bayesian methods, minimax principle. Point estimation. Lehmann-Scheffe and Cramer-Rao theorems. Set estimation.

STAT 701 Mathematical Statistics II. (3) Prerequisite, STAT 700 or equivalent. Testing hypotheses-parametric methods. Neyman-Pearson lemma. Uniformly most powertul tests Unbiased tests. Locally optimal tests. Nonparametric methods, Wilcoxon, Fisher-Yates, median tests. Linear models, analysis of variance, regression and correlation. Sequential 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 Rank tests. Invariant set estimation. Linear models with applications to analysis of variance and regression. Elements of asymptotic theory. Minimax principle and Hunt-Stein theorem.

STAT 720 Nonparametric Statistics. (3) Prerequisite, STAT 421 or equivalent. Order statistics. Nonparametric point and set estimation. Tolerance regions. Invariance principle and its applications. Large sample properties and optimality criteria. Rank statistics, their distributions and moments. 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, incomplete.

STAT 798 Selected Topics in Statistics. (3) Prerequisite, consent of instructor.

STAT 799 Master's Thesis Research. (1-6)

STAT 899 Doctoral Dissertation Research. (1-8)

Measurement and Statistics Program

Professor and Chairman: Giblette
Professors: Dayton, Stunkard
Associate Professors: Johnson, Schafer, Sedlacek
Assistant Professors: MacReady, Rogers

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 nonthesis 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 is applied to measurement.

EDMS 446 Quantitative Research Methods I. (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 practical experience in program writing for solving statistical and educational research problems.

EDMS 489 Field Experiences in Measurement and Statistics. (1-3) Prerequisites, at least six credits in education courses 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 for education majors. Repeatable for credit to a maximum of six credits.

EDMS 498 Special Problems in Measurement and Statistics. (1-3) Prerequisite, consent of instructor. Available only to education majors who have formal plans for individual study of approved problems. Repeatable for credit to a maximum of six credits.

EDMS 622 Theory and Practice of Standardized Testing. (3) Prerequisite, EDMS 410, 446 or 451. Study of groups 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 of 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 educational 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) Registration required to the extent of 6 hours 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 thesis, 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, nor more than eighteen semester hours. In the seminar and in EDMS 899.

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 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 EDMS 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDMS 899 Doctoral Dissertation Research. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Mechanical Engineering Program

Professor and Chairman: Dally
Professors: Allen, Anand, Armstrong, Asimow, Berger, Cunniff, Fourney, Hsu, Irwin, Jackson, Marcinkowski, Sayre, Shreeve, Talaat, Yang
Associate Professors: Buckley, Hayleck, Marks, Morse, Sallet, Walston
Assistant Professors: Andry, Holloway, Hurdis, Kirk, Kobayashi, Owens, Sargent, Tsui
Lesturers: 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 three different areas of specialization including: 1) Energy, 2) Industrial and Systems Engineering, and 3) 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 four main topics which include solar energy, energy conversion heat and mass transfer and thermodynamics. Solar energy studies deal with the engineering applications of solar thermal energy to heating, cooling, and the generation of electricity and with photovoltaic, biological and wind-power systems. Included in energy conversion coverage are thermoelectric, thermoionic, photovoltaic, fuel cells and magnetohydrodynamics. In studies of heat and mass transfer, procedures for developing both analytical, empirical and experimental solutions to heat transfer problems of conduction, convection and radiation; of pure mass transfer and of combined heat and mass transfer are developed. The coverage in thermodynamics includes macroscopic and microscopic considerations of processes, statistical methods and irreversible processes.

2) 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. Research programs often stress specific as well as interdisciplinary areas of investigation. Experimental research facilities are available for studies of polymer processes, control systems and tribology.

3) Mechanics. This area of specialization provides an opportunity for preparation in advanced analytical and experimental methods in both solid and fluid 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 experimental mechanics, noise and vibration control, acoustics, numerical modeling, linear and non-linear mechanics, fracture mechanics, boundary layers and jets, two phase flow, vortex dynamics, free surface phenomena, oceanography and shock waves. Laboratory facilities are available for research in stress analysis, fracture, acoustics, photoelasticity, gas dynamics, hydromechanics, vortex motions and low speed flow phenomena.

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, ENME 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 at least 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 optimization 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, queuing model, 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 414 Solar Energy Applications in Buildings. (3) Crosslisted as ARCH 414 and ENME 414. Prerequisites, ARCH 311, or ENME 321 (or equivalent), or consent of instructor. Lecture, three hours per week. Methods of utilizing solar energy to provide heating, cooling, hot water, and electricity for buildings; survey of related techniques for reducing energy consumption in buildings. Flat-plate and focusing solar collectors, heating and cooling systems, water heaters, energy storage, solar cells, solar-thermal power systems. Quantitative evaluation of system efficiencies; economics of solar energy utilization; structural and esthetic integration of solar collectors and system components into building designs.

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. Thermodynamics 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, heterogenous 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, tsunamies, 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 disks.

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. Solution of problems expressed by partial differential equations. Application of Fourier series and intergrals, LaPlace transformation, Bessel functions, LeGendre polynominals 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 treated.

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 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 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) Prerequisites, 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 601 Advanced Mechanical Engineering Design. (3) Prerequisites, 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. Prerequisites, 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 linerization techniques; introduction to state space formulation of differential equations; systems with stochastic inputs; stability, introduction to optimum switched systems; adaptive control systems.

ENME 620 Advanced Thermodynamics. (3) First and second semesters. Three lectures a week. Prerequisites, ENME 421. Advanced problems in thermodynamics on compression of gases and liquids, combustion and equilibrium, humidification and refrigeration and availability. Statistical thermodynamics, partition functions, irreversible processes. Transport phenomena

ENME 621 Advanced Thermodynamics. (3) First and second semesters. Three lectures a week. Prerequisites, ENME 620. Advanced problems in thermodynamics on compression of gases and liquids, combustion and equilibrium, humidification and refrigeration and availability. Statistical thermodynamics, partition functions, irreversible processes. Transport phenomena.

ENME 622 Energy Conversion—Solid State. (3) First and second semesters. Three lectures per week. Prerequisite, ENME 421. Combustion, thermo-electric, thermionic fuel cells, reactors, magnetohydrodynamics, kinetics of reactors, fission and fusion.

ENME 623 Energy Conversion—Solid State. (3) First and second semesters. Three lectures per week. Prerequisite, ENME 421. Combustion, thermo-electric, thermionic fuel cells, reactors, magnetohydrodynamics, kinetics of reactors, fission and fusion.

ENME 624 Energy Conversions—Plasma State. (3) First and second semesters. 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 625 Energy Conversions—Plasma State. (3) First and second semesters. 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 Advanced Heat Transfer. (3) First and second semesters. 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 627 Advanced Heat Transfer. (3) First and second semesters. 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) First and second semesters. 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) First and second semesters. Three lectures per week. Prerequisites, ENME 640. 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 642 Compressible Flow. (3) First and second semesters. 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) First and second semesters. 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) First and second semesters. 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 flows, free mixing flows. This course is equivalent to ENAE 675, 676

ENME 645 Viscous Flow. (3) First and second semesters. 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) First and second semesters. 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) First and second semesters. 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) First semester. 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) Second semester. 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) First semester. 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) Second semester. Three lectures per week. Prerequisite, ENME 641. 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. Asyptotic methods. Non-linear resonance. Relaxation oscillations. Self-excited vibrations.

ENME 666 Stress Waves in Continuous Media. (3) First and second semesters. 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 667 Stress Waves in Continuous Media. (3) First and second semesters. 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) First semester. 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 survaces 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) Second semester. 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) First and second semesters. 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, limit analysis, analysis and metal working theory and applications.

ENME 673 Plasticity. (3) First and second semesters. 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, analysis and metal working theory and applications.

ENME 674 Non-Linear Elasticity. (3) First semester. 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 non-linear problems are developed. Plane problems, infinitesimal strain super-imposed on a given finite strain, wave propagation and stability problems are considered.

ENME 675 Viscoelasticity. (3) Second semester. 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 constitive equation for variance visco-elastic materials. Steady shear flows, helical flow, visco-elastic torsion and problems arising from the linear visco-elastic theory are considered.

ENME 676 Linear and Nonlinear Elastic Shells. (3) First and second semesters. 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 thier 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 mechanical engineering problems, emphasis is on the formulation and solution of equilbrium, Eignvalue and propagation 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 Advanced Structural Dynamics I. (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 earth quake, non-linear systems, random vibrations and structural failure from random loads. Prerequisites, ENME 602, 603 or equivalent.

ENME 761 Advanced Structural Dynamics II. (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. Prerequisites, ENME 602, 603 or equivalent.

ENME 788 Seminar. (1-16) First or second semester. 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

Professor and Director: Landsberg
Research Professor: Faller
Associate Professors: Israel[1], Rodenhuis, Thompson, Vernekar
Assistant Professor: Ellingson
Visiting Professor: Fritz
Assistant Visiting Professor: Overcamp

[1]joint appointment with Civil Engineering

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.

The Graduate Program in Meteorology is in the Division of Mathematical and Physical Sciences and Engineering at the University and maintains its traditional research and teaching associations with the Division's Institute for Fluid Dynamics and Applied Mathematics. In addition to the Meteorology faculty, its members include about 35 regular faculty and a number of part-time and visiting scholars, involved in a number of related fields such as atmospheric optics, atmospheric and space physics, atomic and molecular collisions, geophysics, oceanography, fluid dynamics, plasma physics, kinetic theory and statistical mechanics, control theory, differential

equations, mathematical models of physical, medical and social problems, numerical analysis, theoretical biology, and history of science.

The laboratories are well equipped and include elaborate apparatus for fluid dynamical experimentation in rotating systems, a tank for studying the interaction of water waves and wind, continuous weather facsimile data, a complete solar radiation station, an Automatic Picture Transmission satellite receiving station, several micro-meteorological field stations, a mobile micrometeorological survey vehicle, instrumentation for research in air quality control, and a laboratory for analysis of air pollution samples.

Aside from general library facilities on the campus, 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 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 program also maintains a meteorological data bank consisting of the data for four outlying weather stations on the university's farms, northern hemisphere data tabulations on microfilm, and historical weather information which includes, among other things, daily weather maps extending back to 1899 and a complete set of climatological data for the United States extending back fo 1917. A complete collection of past weather records for the state on punched cards and a magnetic tape are also maintained.

Graduate Assistantships are available to qualified graduate students. Research Assistants carry on research in the general areas of synoptic and dynamic meteorology, satellite meteorology, micrometeorology and air pollution, theoretical or experimental fluid dynamics, atmospheric radiation, and general circulation. Stipends are dependent on the student's background and experience and are maintained at a competitive level.

To qualify for the M.S. degree, a minimum of 24 semester credits, distributed over major and minor subject areas is required The candidate is also required to register for six semester credits of research leading to a thesis demonstrating his ability to produce a coherent account of research in which he has participated. A final oral examination over this research is administered prior to an award of the degree. Full time students with an appropriate background in meteorology can complete the M.S. program in one calendar year.

To qualify for the Ph.D. degree, the candidate must select a major and one or two closely related minor subject areas. Each student is expected to develop a major course work program with his advisor which will provide adequate preparation for the comprehensive exams, which test the student's mastery of essential subject matter, and adequate background for a successful research program leading to a Ph.D. dissertation. Minor course work programs are individually tailored to the needs and interests of the student and consist of at least 24 semester credits of course work beyond the bachelor's degree. During his Ph.D. program, a candidate must demonstrate a reading competence in French, German, Russian, Spanish or Japanese. Ability to do independent research must be shown by a written dissertation on some topic connected with meteorology A final examination consisting of an oral presentation and defense of the work is conducted prior to an award at the Ph.D degree.

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 413 Atmospheric Processes on Molecular and Atomic Scale. (3) Prerequisite, senior or graduate standing in the physical or engineering sciences, at least one year of college physics, a familiarity with differential and integral calculus. An introduction to atmospheric processes with an emphasis on atomic and molecular effects. Theories of the gas phase interactions of neutral atoms and molecules and charged particles applied to meteorological and atmospheric topics.

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 themohaline 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, isunamis, 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 441 Weather Map Discussion and Practice Forecasting I. (1) Prerequisite, METO 301 or equivalent. Corequisite, METO 410. Discussion of current weather situation on the basis of information received by facsimile from National Meteorological Center. Use of computer-produced prognostic information, critique of previous forecast, and briefing on expected weather conditions by experienced forecasters. Preparation of practice forecasts, using all available information. Readings in synoptic meteorology.

METO 442 Weather Map Discussion and Practice Forecasting. (1) Prerequisite, METO 441. A continuation of METO 441.

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 or partial differential equations; application to the equations of atmospheric motion; Eulerian, LaGrangian and apectral 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 scalars 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 turbulence; 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 646 Atmospheric Optics. (3) Prerequisites, METO 412, 413, MATH 246 or equivalent. Quantitative assessment of radiative energy transfers in the atmosphere; absorption and scattering by atoms, molecules and particulates; emission by excited species. Spectroscopic analysis methods; laser assay of atmosphere for natural species and pollutants.

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. (1-3) 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 698 Seminar in Meteorology. (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 invited guest speakers.

METO 699 Seminar in Meteorology. (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 invited guest speakers.

METO 799 Master's Thesis Research. (1-6)

METO 899 Doctoral Dissertation Research. (1-8)

Microbiology Program

Professor and Chairman: Young
Professors: Colwell, Doetsch, Goldsby[1], Hetrick, Laffer, Pelczar
Associate Professors: Cook, MacQuillan, Roberson
Assistant Professors: Vaituzis, Voll, Weiner
Lecturers: Janicki, Stadtman

[1]Joint appointment with Chemistry

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 Microbiology. (2) Two lecture periods a week. Prerequisite, 8 credits in microbiology or consent of instructor. History and philosophy of classification. Alpha, numerical and molecular genetic taxonomy. Methods used in microbial identification and classification.

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.

MICB 420 Epidemiology and Public Health. (2) Two lecture periods a week. Prerequisite, MICB 200. History, characteristic features, and epidemiology of the important responsibilities; vital statistics.

MICB 430 Marine Microbiology. (2) Two lectures per week. Morphology, biochemistry and ecology of marine microorganisms including fungi, yeasts, bacteria and viruses. Properties of marine bacteria, such as luminescence, metal ion requirements for growth, production of ectocrine compounds, and sampling and culturing marine microorganisms, are covered.

MICB 431 Marine Microbiology Laboratory. (2) Two two-hour labs per week. Morphology, biochemistry and ecology of marine microorganisms. Properties of marine bacteria; luminescence, metal ion requirements, endocrine compound production, sampling and culturing, culturing trips on the Chesapeake Bay and the deep sea research cruise.

MICB 440 Pathogenic Microbiology. (4) Two lectures and two 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.

MICB 450 Immunology. (4) Two lectures and two two-hour laboratory periods a week. Prerequisite, MICB 440. Principles of immunity; hypersensitiveness. Fundamental techniques of immunology.

MICB 460 General Virology. (4) Two lectures and two 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.

MICB 470 Microbial Physiology. (4) Two lectures and two 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 affects of the physical and chemical environment on them.

MICB 490 Microbial Fermentations. (2) Second semester. Two lecture periods a week. Prerequisite, MICB 470. Principles and practice in industrial fermentation processes, and the study of fermentative metabolism in microorganisms.

MICB 491 Microbial Fermentations Laboratory. (2) Second semester. 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.

MICB 674 Bacterial Metabolism. (2) Second semester. 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.

MICB 688 Special Topics. (1-4) First semester. 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) Second semester. Prerequisites, 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 two two-hour laboratory periods a week. Prerequisites, MICB 440 and 8 additional hours in microbiology or advance courses in allied biological fields. MICB 450 is

strongly recommended. Primarily a study of fungi associated with human and animal diseases, with practice in the methods of isolation and identification.

MICB 714 Cytology of Bacteria. (2) A colloquium for graduate students in biological sciences covering structure-function relationships in bacteria. Formal presentations are required. Prior or concurrent enrollment in ANSC 610 and/or ZOOL 612 is recommended

MICB 750 Advanced Immunology. (2) Second semester. Two lectures a week. Antigens, antibodies, and their interactions. Research fundamentals in immunology and immunochemistry.

MICB 751 Immunology Laboratory. (2) Second semester. Two three-hour laboratory sessions a week. Prerequisite, consent of the instructor. Techniques in experimental immunology and immunochemistry.

MICB 760 Virology and Tissue Culture. (2) Second semester. Two lecture periods a week. Prerequisite, MICB 440 or equivalent. Physical, chemical and biological properties of viruses; viral replication; major virus groups.

MICB 761 Virology and Tissue Culture Laboratory. (2) Second semester. 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.

MICB 774 Advanced Bacterial Metabolism. (1) Second semester. 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.

MICB 780 Genetics of Microorganisms. (2) First semester. 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.

MICB 781 Microbial Genetics Laboratory. (2) Two three-hour laboratory meetings 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.

MICB 788 Seminar. (1) First semester.

MICB 789 Seminar. (1) Second semester.

MICB 799 Master's Thesis Research. (1-6)

MICB 899 Doctoral Dissertation Research. (1-8)

Music Program

Professor and Chairman: Troth

Professors: Berman, Bernstein, deVermond, Folstrom, Gordon, Grentzer[1], Heim, Helm, Hudson, Johnson, Moss, Taylor[1], Traver, Ulrich

Associate Professors: Blum[1], Garvey, Head, Meyer, Montgomery, Nossaman, Pennington, Schumacher, Serwer, True, Urban, Wakefield

Assistant Professors: Davis, Gould, Kuhn, Signell, Wilson

[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.

MUSC 400 Music Pedogogy. (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 428 Repertoire Coaching of Vocal or Chamber Music. (2) Prerequisite or corequisite, MUSC 328. A course for piano students who wish to go further than the work offered in MUSC 128, 228, and 328 by becoming specialists in the areas of vocal coaching or chamber music coaching. Elements of pedogogy, conducting, and responsible artistic decision-making for the entire musical production.

MUSC 429 Opera Theater. (2-3) Ten hours per week. Open to music and non-music majors with consent of director. Advanced techniques of operatic production; preparation, rehearsal, and performance of operatic works from both the traditional and contemporary repertory. Repeatable to a maximum of twelve credits.

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 436 Jazz: Then and Now. (3) Major styles and influential artists of the past 75 years of jazz.

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 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 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 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) Prerequisite, MUSC 250, 251. A study of the organizing principles of musical composition, their interaction in musical forms, and their functions in different styles.

MUSC 451 Analysis of Music. (3) Prerequisite, MUSC 450 or permission of instructor. An advanced course in the analysis of tonal music. Discussion of individual works, with emphasis on their unique characteristics and on the relation of analysis to performance.

MUSC 452 Keyboard Harmony. (2) Prerequisites, MUSC 209A, MUSC 251 or the equivalents. Three laboratory hours per week. Basic instruction in the interpretation of musical scores for larger ensembles at the keyboard. Realization of basso continua parts under performance conditions.

MUSC 453 Class Study of Guitar and Recorder. (2) Prerequisite, consent of instructor or any four of the following: MUSC 102, 103,

113, 114, 116, 117, 120, 121, 202, 203. Three hours per week. Study and development of instrumental technique, pedagogical practices, and materials relating to group performance.

MUSC 459 Electronic Composition. (2) Prerequisite, MUSC 250 and permission of instructor. A basic course in the theory and practice of electronic music, including an investigation of the nature of electronically-generated sound and its modulation in the voltage-controlled studio. Primarily for composition and theory majors. May be repeated once for credit.

MUSC 460 Counterpoint. (2) Prerequisite, 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 461 Counterpoint. (2) Prerequisite, MUSC 250, 251. A course in eighteenth-century contrapuntal techniques. Study of devices of imitation in the invention and the choral 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 466 Structural Counterpoint. (3) Prerequisite, MUSC 461 or permission of instructor. A study of counterpoint not so much in terms of technique as in its role of articulating large-scale tonal structures. Emphasis on analysis as well as written exercises.

MUSC 467 Piano Pedagogy I. (3) A study of major pedagogical treatises in music, and an evaluation of pedagogical techniques, materials, and procedures.

MUSC 468 Piano Pedagogy II. (3) Prerequisite, MUSC 467. Application of the studies begun in MUSC 467 to the actual lesson situation. Evaluation of results. May be repeated once for credit.

MUSC 470 Harmonics 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, poly-harmony, and serial and twelve-tone organization.

MUSC 471 Contemporary Compositional Techniques. (2) Prerequisite, MUSC 470 or permission of instructor. Continuation of MUSC 470, with emphasis on the analysis of individual works written since 1945.

MUSC 478 Composition. (2) Prerequisite, 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) Prerequisite, 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 480 Music in Antiquity and the Middle Ages. (3) Survey of western music from Hellenic times to 1450.

MUSC 481. Music in the Renaissance. (3) Survey of western music from 1450 to 1600.

MUSC 482 Music in the Baroque Era. (3) Survey of western music from 600 to 1750.

MUSC 483 Music in the Classic Era. (3) Survey of western music from 1750 to 1820.

MUSC 484 Music in the Romantic Era. (3) Survey of western music from 1820 to 1900.

MUSC 485 Music in the 20th Century. (3) Survey of western music from 1900 to the present.

MUSC 486 Orchestration. (2) Prerequisite, 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 487 Orchestration. (2) Prerequisite, 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 Conducting. (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 491 Conducting. (2) Prerequisite, MUSC 490 or equivalent. 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 492 Keyboard Music I. (3) The history and literature of harpsichord and solo piano music from its beginning to the romantic period. Emphasis is placed on those segments of repertoire which are encountered in performance and teaching situations at the present time.

MUSC 493 Keyboard Music II. (3) Prerequisite, MUSC 492. The history and literature of harpsichord and solo piano music from the Romantic period to the present. Emphasis is placed on those segments of repertoire which are encountered in performance and teaching situations at the present time.

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 diversified chamber music for standard media. May be repeated for credit to the maximum credit designated in the student's major degree program.

MUSC 621 Documents of Theory and Aesthetics: Ancient, Medieval and Renaissance. (3) Writings about music in antiquity, the Middle Ages, and the Renaissance.

MUSC 622 Documents of Theory and Aesthetics: Baroque. (3) Writings about western music from 1600 ro 1750.

MUSC 623 Documents of Theory and Aesthetics: Classic. (3) Writings about western music from 1750 to 1820.

MUSC 624 Documents of Theory and Aesthetics: Romantic. (3) Writings about western music from 1820 to 1900.

MUSC 625 Documents of Theory and Aesthetics: 20th Century. (3) Writings about western music from 1900 to the present.

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 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 640 Performance Practice I. (3) Problems in the Performance of music lying primarily outside the standard repertory. Mainly for performance majors.

MUSC 641 Performance Practice II. (3) Problems in the performance of music lying primarily outside the standard repertory. Mainly for performance majors. Continuation of MUSC 640.

MUSC 642 Early Music Notation. (3) Aspects of notation in music before 1600; transcription into modern notation.

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 679 Seminar in Ethnomusicology. (3) Prerequisite, MUSC 434-435. Selected problems in ethnomusicology. Independent research in such topics as transcription, analysis, and taxonomy.

MUSC 680 Seminar in Music of Antiquity and the Middle Ages. (3) Special research topics in music.

MUSC 681 Seminar in Music of the Renaissance. (3) Special research topics in music from 1450 to 1600.

MUSC 682 Seminar in Music of the Baroque Era. (3) Special research topics in music from 1600 to 1750.

MUSC 683 Seminar in Music of the Classic Era. (3) Special research topics in music from 1750 to 1820.

MUSC 684 Seminar in Music of the Romantic Era. (3) Special research topics in music from 1820 to 1900.

MUSC 685 Seminar in Music of the 20th Century. (3) Special research topics in music from 1900 to the present.

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 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 Advanced Seminar in Music Pedagogy. (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 performance and literature.

MUSC 801 Advanced Seminar in Music Pedagogy. (3) Prerequisites, Music 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 performance and literature.

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.

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)

Music Performance

Music performance courses are available in three series.

Minor Series—MUSP 402, 403. Intended for either music majors studying a secondary instrument or non-music majors. **Principal Series—MUSP 405, 406, 409, 410, 609, 610.** Intended for majors in music programs other than performance. **Major Series—MUSP 415, 416, 419, 420, 619, 620, 815, 816, 817.** Intended for students majoring in performance.

Instrument designation: each student taking a music performance course must indicate the instrument chosen by adding a suffix to the proper course number, such as: MUSP 402A Music Performance—Piano. Suffix instrument: A—Piano, B—Voice, C—Violin, D—Viola, E—Cello, F—Bass, G—Flute, H—Oboe, I—Clarinet, J—Bassoon, K—Saxophone, L—Horn, M—Trumpet, N—Trombone, O—Tuba, P—Euphonium, Q—Percussion, R—Organ, S—Guitar, T—Composition, U—Conducting, V and W—Open, X—HIST INST-Keyboard, Y—HIST INST-Strings, Z—HIST INST-Winds.

400-Level Courses in the Minor Series: Half-hour lesson and six practice hours per week. Prerequisite, permission of department chairman and the next lower course on the same instrument.

400-Level Courses in the Principal or Major Series: 2 or 4 credits. One-hour lesson and six practice hours per week if taken for 2 credits; or one-hour lesson and fifteen practice hours per week if taken for 4 credits. Prerequisite, permission of department chairman and the next lower course on same instrument.

MUSP 402 Music Performance. (2) Senior course, in the minor series.

MUSP 403 Music Performance. (2) Senior course, in the minor series.

MUSP 405 Music Performance. (2-4) Junior course in the principal series.

MUSP 405 Music Performance. (2-4) Junior course in the principal series.

MUSP 409 Music Performance. (2-4) Senior course in the principal series.

MUSP 410 Music Performance. (2-4) Senior course in the principal series. Recital required.

MUSP 415 Music Performance. (2-4) Junior course in the major series.

MUSP 416 Music Performance. (2-4) Junior course in the major series.

MUSP 419 Music Performance. (2-4) Senior course in the major series.

MUSP 420 Music Performance. (2-4) Senior course in the major series. Recital required.

MUSP 609 Interpretation and Repertoire. (2) Prerequisite, permission of department chairman and graduate standing in performance in the principal series.

MUSP 610 Graduate Music Performance. (4) Prerequisite, MUSP 609 and permission of department chairman. Recital course in the principal series.

MUSP 619 Interpretation and Repertoire. (2) Prerequisite, permission of department chairman and graduate standing in performance in the major series.

MUSP 620 Graduate Music Performance. (4) Prerequisite, MUSP 6 ? and permission of department chairman. Recital course in the major series.

MUSP 815 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 and permission of department chairman. Recital course.

MUSP 816 Interpretation, Performance, and Pedagogy. (4) Recital course. Prerequisite, MUSP 815 and permission of department chairman.

MUSP 817 Interpretation, Performance, and Pedagogy. (4) Recital course. Prerequisite, MUSP 816 and permission of department chairman.

Music Education

MUED 420 Materials, Techniques and Organization for the Instrumental Music Program. (2) Prerequisites, MUSC 113, 114, 116, 117, 120, 121, 491 and MUED 470; or consent of instructor. A study of instructional materials, performing repertoire, rehearsal techniques, and program planning for the school instrumental program. Organization, scheduling, budgeting and purchasing are included.

MUED 438 Special Problems in the Teaching of Instrumental Music. (2-3) Prerequisite, MUSC 113-213 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 470 General Methods for Teaching Music. (4) Prerequisite, MUED 197 and EDHD 300; or consent of instructor. Music in the education of youth, ages six to eighteen. Basic planning and implementation of music in-

struction, vocal and instrumental, for the general and specialized programs of music instruction in the schools; use of current methods, materials, and teaching techniques. Six class hours per week including field experiences in designated elementary and secondary schools.

MUED 472 Choral Techniques and Repertoire. (2) Prerequisites, MUED 470 and MUSC 490. Rehearsal techniques for developing appropriate diction, tone, production, intonation, phrasing, and interpretation of choral music; examination of a wide variety of repertoire for use by choral performing groups on the elementary and secondary levels.

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 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 674 Choral Conducting and Repertoire. (3)

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. (2-4) 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, 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 pedogogical 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 reactor safety, reactor thermal/hydraulics, nuclear fuel management, transport theory, 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 deparmental 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 250 KW swimming pool type using enriched uranium.

The Nuclear Engineering program is administered by the Department of Chemical Engineering.

ENNU 430 Radioisotope Power Sources. (3) Prerequisite, ENNU 215 or permission of instructor. Principles and theory of radioisotope 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 460 Nuclear Heat Transport. (3) Prerequisite, ENNU 450. Heat generation in nuclear reactor cores, conduction and transfer to coolants. Neutron flux distributions, fission and heat release. Steady and unsteady state conduction in fuel elements. Heat transfer to nonmetallic and metallic coolants. Heat transfer with phase change. Thermal design of reactor cores.

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, senior standing in engineering or 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, multigroup diffusion theory in one and two dimensions and fine structure flux calculations using transport theory.

ENNU 490 Nuclear Fuel and Power Mangement. (3) Prerequisites, ENNU 460 and 480, or consent of instructor. Physics and economics of the nuclear fuel cycle utilizing existing design codes. Mining, conversion, enrichment, fabrication, reprocessing processes. Effects of plutonium recycle, in-core shuffling, fuel mechanical design and power peaking on fuel cycle costs.

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) Prerequisite, ENNU 450 or consent of instructor. 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 Boltzman transport equation is developed together with approximations such as PH, 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) Second semester. 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. (1-16)

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 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 chemonuclear reactors.

ENNU 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 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 Nuclear Reactor Laboratory. (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 startup and operation, shielding, control, neutron flux distributions, neutron and gamma spectrum, cross section measurements.

ENNU 672 Nuclear Reactor Laboratory. (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 startup and operation, shielding, control, neutron flux distributions, neutron and gamma spectrum, cross section measurements.

ENNU 720 Neutral Particle Transport Theory. (3) First semester, 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) First semester. 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) Second semester. 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) First semester, 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) Prerequisites, 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 Dissertation Research. (1-8)

Nutritional Sciences Program

Professor and Chairman: Keeney (Chemistry)

Professors: Leffel, Young (Animal Science); Goldsby, Holmlund, Keeney, Rollinson, Veitch (Chemistry); Davis, King, Mattick, Vandersall, Williams (Dairy Science); Prather (Food Nutrition and Institution Administration); Shaffner (Poultry Science)

Associate Professors: Lakshmanan, Martin, Sampugna (Chemistry); Ahrens, Butler, Cox (Food, Nutrition and Institution Administration); Thomas, Poultry Science)

Assistant Professors: DeBarthe, McCall (Animal Science); Campagnoni, Hansen (Chemistry); Bull (Dairy Science); Berdanier, Eheart (Food, Nutrition and Institution Administration); Coon, 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.

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 rations will be presented.

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.

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) First semester. Two lectures and one two-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.

NUSC 460 Therapeutic Human Nutrition. (3) Second semester. 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 463 Nutrition Laboratory. (2) Prerequisite, ANSC/NUSC 401 or concurrent registration. Six hours of laboratory per week. Digestibility studies with ruminant and monogastric animals. Proximate analysis of various food products, and feeding trials demonstrating classical nutritional deficiencies in laboratory animals.

NUSC 600 Recent Progress in Human Nutrition. (3) First semester. Three lectures per week. Recent developments in the science of nutrition with emphasis on interpretation for application in health and disease.

NUSC 601 Advanced Ruminant Nutrition. (2) First semester. 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.

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.

NUSC 604 Vitamins. (3) Prerequisites, ANSC 401 and CHEM 461. Two one-hour lectures and one two-hour discussion period per week. Advanced study of the fundamental role of vitamins and vitamin-like cofactors in nutrition including chemical properties, absorption, metabolism, excretion and deficiency syndromes. A critical study of the biochemical basis of substances and of certain laboratory techniques.

NUSC 610 Readings in Nutrition. (1-3) Second semester. 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) Second semester. Prerequisites, NUSC 402 or 450, 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 614 Proteins. (2) Second semester. 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.

NUSC 620 Nutrition for Community Services. (3) First semester. 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 Advanced Nutrition Laboratory. (3) Prerequisite, ANSC/NUSC 401 and either CHEM 462 or NUSC 670. One hour of lecture and six hours of laboratory per week. Basic instrumentation and techniques desired for advanced nutritional research. The effect of various nutritional parameters upon intermediary metabolism, enzyme kinetics, endocrinology, and nutrient absorption in laboratory animals.

NUSC 670 Intermediary Metabolism in Nutrition. (3) Second semester. 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.

NUSC 680 Human Nutritional Status. (3) First semester, alternate years. Methods of appraisal of human nutritional status, to include dietary, biochemical and anthropometric techniques.

NUSC 698 Seminar in Nutrition. (1-3) First and second semesters. 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) First and second semesters. 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) First and second semesters. Oral reports on special topics or recently published research in nutrition. Distinguished scientists are invited as guest lecturers. A maximum of three credits allowed for the M.S.

NUSC 899 Doctoral Dissertation Research. (1-8) First and second semesters. 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 completions, and reporting the results in the form of a dissertation.

Oriental and Semitic Language and Literature Courses

Chinese

CHIN 401 Readings in Chinese History and Literature I. (3) Prerequisite, CHIN 302 or equivalent. A language training course using original sources in history and literature.

CHIN 402 Readings in Chinese History and Literature II. (3) Prerequisite, CHIN 401 or equivalent. A language course training using original sources in history and literature.

CHIN 403 Classical Chinese I. (3) Prerequisite, CHIN 302. Introductory classical Chinese using literary and historical sources in the original language.

CHIN 404 Classical Chinese II. (3) Prerequisite, CHIN 302. Further classical studies by various writers from famous ancient philosophers to prominent scholars before the new culture movement.

CHIN 405 Advanced Conversation and Composition I. (3) Prerequisite, CHIN 202 or equivalent. Review of contemporary grammar with emphasis on contemporary materials and free composition.

CHIN 406 Advanced Conversation and Composition II. (3) Prerequisite, CHIN 405 or equivalent. Analysis of the role of language in literature; study of principles and techniques of advanced composition, speech composition, letter and report writing.

CHIN 411 Chinese Civilization. (3) This 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. (3) 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. (3) Yuan dynasty drama through Ming and Ching novels and essays to the modern and revolutionary short stories, essays and poetry of twentieth century China.

CHIN 421 Chinese Linguistics. (3) Prerequisite, CHIN 102 or equivalent.

CHIN 422 Chinese Linguistics. (3) Prerequisite, CHIN 102 or equivalent.

CHIN 431 Translation and Interpretation I. (3) Prerequisite, CHIN 202 or equivalent. Introduction to the history and theories of translation/interpretation; contrastive studies of the structures of English and Chinese; development of the four language skills.

CHIN 432 Translation and Interpretation II. (3) Prerequisite, CHIN 431 or equivalent.

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.

HEBR 422 The Hebrew Bible. (3) Continuation of HEBR 421.

HEBR 431 Modern and Contemporary Hebrew Literature. (3) The period of the Haskalah (enlightenment) and the period of the Tehiah (modern revival).

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.

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.

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.

HEBR 498 Special Topics in Hebrew. (3) Prerequisite, as announced in the schedule of classes for each topic. Repeatable for a maximum of six credits provided the content is different.

Philosophy Program

Professor and Chairman: Gorovitz
Professors: Pasch, Perkins, Schlaretzki, Svenonius
Associate Professors: Brown, Celarier, Lesher, Martin
Assistant Professors: Johnson, Kress, Odell

The Department of Philosophy offers graduate programs leading to the M.A. and Ph.D. degrees, with emphasis on contemporary British and American philosophy and the bearing of philosophy on other disciplines.

Ordinarily a person seeking the Ph.D. enters that program directly, without first pursuing the the M.A. program (though the M.A. may be earned on the way to the Ph.D.) The Ph.D. student works closely with a faculty committee having both advisory and tutorial functions in arranging and pursuing a course of studies leading to qualification for Ph.D. candidacy. The primary requirement is that the student demonstrate competence in two or three areas of philosophy, including either epistemology or metaphysics. How competence is to be demonstrated—whether through course work, papers, or written or oral examinations—is determined by the committee in consultation with the student. A substantial part of the demonstrations of competence for at least two of the areas must consist in one or more submitted papers.

Foreign language skills are required insofar as demanded by the individual student's research. Knowledge of the language of symbolic logic is required of all students early in their course of study.

An accelerated Ph.D. 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 qualification for candidacy. A maximum of four years thereafter is allowed for completion of the dissertation. In the accelerated program the dissertation must be completed no later than five years after the student enters the program.

The program leading to the M.A. degree provides both a thesis option and a non-thesis option. In both cases, the requirements differ considerably from those of the Ph.D. program.

Students seeking admission to the Ph.D. program should normally 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 required also to submit a sample of his written work on a philosophical topic. The letters and paper, as well as the G.R.E. test scores, should be sent directly to the Department of Philosophy.

Well-prepared entering students have a good chance of receiving some financial support in the first year. Beyond the first year, support (usually by assistantships) for a reasonable period of time for students in good standing in the Ph.D. program is normal.

Interested persons are urged to write to the department for a brochure which describes the Ph.D. and M.A. programs in greater detail.

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.

PHIL 414 The Philosophy of Aristotle. (3) Prerequisites, PHIL 310 and 320. A critical study of selected portions of Aristotle's writings.

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. (3) 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.

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.

PHIL 445 Political and Social Philosophy II. (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.

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.

PHIL 455 Philosophy of the Social Sciences. (3) Prerequisites, six hours in social science or consent of instructor. A discussion 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.

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.

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 verification 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.

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, and language, truth and confirmation.

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.

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.

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.

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.

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) Prerequisite, consent of chairman of tutorial-advisory committee. Repeatable to a maximum of 6 credits.

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, Ingram, Kelly, Kramer, Steel
Associate Professors: Church, Dotson, Hult, Love,[1] Santa Maria
Assistant Professors: Dainis, Fringer, Johnson, Tyler, Vander-Velden, Wrenn[2]

[1]Joint appointment with Secondary Education

The graduate student majoring in Physical Education may pursue the degrees of Master of Arts or Doctor of Philosophy. The two major objectives of these programs are: (1) to study the discipline of physical education by examining the effects of physical activity on individuals from a physiological, kinesiological, psychological, social and historical point of view; and (2) to acquaint the student with curricular aspects of physical education, to improve the quality of teaching, and to offer the student ways of improving the administration and supervision of programs in schools and colleges.

The graduate program is organized into three divisions, offering major emphasis as follows: (1) Division of Sport Studies, including history of sport, psychology of sport, and sociology of sport; (2) Division of Bio-physical Studies, with specialties in physiology of exercise, motor learning and biomechanics; and (3) Division of Curricular Studies, with emphasis on curriculum-supervision-administration, teacher education, and adapted programs.

In addition to the minimum requirements of the Graduate School, adequate preparation should include such upper division requirements as kinesiology, physiology of exercise, measurement in physical education, history and philosophy of sport and physical education, and adapted physical education. In addition, prerequisite background is required in biological and physical sciences and mathematics, and in the behavioral sciences.

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. The doctoral student is required to take this examination only when entering the program without a master's degree with a major in physical education. 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 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 and intramurals. 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 497 Independent Studies Seminar. (3) Discussions of contemporary issues vital to the discipline, critiques of research in the student's area/areas of special interest, completion of a major project where the student will be asked to demonstrate the ability to carry out investigative processes in problem solving and critical writing under faculty direction.

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 performance 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 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, factor determining championship performances, and physical fatigue.

PHED 775 Advanced Analysis of Human Motion. (3) Prerequisites, PHED 400, 460, college Algebra or equivalent of 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, Benedict[6], Benesch[6], Bhagat, Brill, Davidson, Day, DeSilva, Dorfman[3], Dragt, Falk, Ferrell, Friedman, Ginter[6], Glasser[1], Glover, Greenberg, Griem, Griffin, Hayward, Holmgren, Hornyak, Krall, MacDonald, Marion, McDonald, Misner, Myers, Oneda, Pati, Prange, Pugh, Rado, Reiser[2], Slawsky, Snow, Sucher, Trivelpiece, Wall, Weber, Woo, Yodh, G.T. Zorn, Zwanzig[6 3]

Associate Professors: Anderson, Bardasis, Beall, Bennett, Chang, Currie, DeRocco[6], Dixon, Earl, Fivel, Glick, Gloeckler, Hammer, Kacser, H. Kim[2], Y.S. Kim, Korenman, Krisher[6], Minkiewicz, Pechacek, Redish, Richard, Roos, Roush[5], Sengers[6], Steinberg, Stephenson, B.S. Zorn

Assistant Professors: Bagchi, Brayshaw, Chant, Chen, Connors, Drew, Ellsworth, Gammon, Glosser, Goldberg, Gowdy, Guillory, Hill, Khoury, Layman[4], Martin, McClellan, O'Gallagher, Steinberg, Wallace

Visiting Assistant: Dworzecka

[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
[6]Joint appointment with Institute for Molecular Physics

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 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 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.

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 oppor-

tunity 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 deficiencies in one or more of these areas may be admitted, but will be expected to remedy such deficiencies as soon as possible.

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) Three lectures a week. Prerequisites, PHYS 263 or 284 and MATH 240, or consent of 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 284, or PHYS 404 and 405, or PHYS 263 and consent of instructor, and also MATH 241. A study of the theoretical foundations of mechanics, with extensive applications of the methods. Also various mathematical tools of theoretical physics

PHYS 411 Elements of Theoretical Physics—Electricity and Magnetism. (4) Prerequisite, PHYS 404 or 410, and PHYS 263 or 284 or 405, or consent of the 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-Bultzmann 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 phenoma 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) Prerequisite, an understanding of undergraduate 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, measurement 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) Credits of 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, 421. Introduction to solid state physics. Electromagnetic, thermal, and elastic properties of metals, semiconductors and insulators.

PHYS 441 Nuclear Physics. (3) Prerequisite, PHYS 404 and 405 or 410, 420 or 421. An introduction to nuclear physics at the pre-quantum-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) Three lectures a week. Prerequisites, PHYS 404 or 410, or ENES 221; and PHYS 405 or 411, or ENEE 380; or consent of instructor. Students without the electricity and magnetism prerequisite but having a familiarity with Maxwell's equations whould check with the instructor. Orbit theory, magneto-hydrodynamics, plasma heating and stability, waves and transport processes.

PHYS 465 Modern Optics. (3) Prerequisites, PHYS 401 and 420 or 421, and 411 or consent of the instructor Designed for students with a background in fundamental optics, the 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 404 and 405 or 410, 420 or 421. 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.

PHYS 483 Introduction to Biophysics. (3) Prerequisite, senior level standing / 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 Prerequisite, PHYS 365, and concurrent enrollment in PHYS 405 or 411. Theory of semiconductor and vacuum tube circuits Application in experimental physics.

PHYS 487 Particle Accelerators, Physical and Engineering Principles. (3) Prerequisites,

PHYS 410, 411 or 271, 321 and 421, or equivalents. Sources or 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 sycIotrons and alternating-gradient sychrotrons: linear accelerators. This course is also listed as ENEE 487.

PHYS 490 History of Modern Physics. (3) Prerequisite, PHYS 420 or 421 or equivalent. Primarily for senior physics majors and first year graduate students. A survey of major discoveries and trends in 20th century physics, including the relations of physics to other sciences, philosophy of science, technology and society.

PHYS 499 Special Problems in Physics. (1-16) 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 work per week. Design and performance of advanced experiments in modern and classical physics.

PHYS 622 Introduction to Quantum Mechanics I. (4) First and second semesters. 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.

PHYS 623 Introduction to Quantum Mechanics II. (3) First and second semesters. Prerequisite, an understanding 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> analytical 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 Electrical Engineering 686.

PHYS 703 Thermodynamics. (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 411 and 602. A study of the determination of behavior of matter from microscopic models, microcanonical, canonical, and grand canonical models. Applications of 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 Seminar in General Physics. (1)

PHYS 719 Seminar in General Physics. (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 hyper-fine 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 of 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) Two lectures per week. 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. Continuation of PHYS 723.

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 semi-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) First and second semesters. 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) First and second semesters. Three lecture hours per week. 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 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) Prerequisite, 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 Seminar in Elementary Particles and Quantum Field Theory. (1)

PHYS 759 Seminar in Elementary Particles and Quantum Field Theory. (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 elctron 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 in special study in advanced physics

PHYS 799 Master's Thesis Research. (1-6)

PHYS 808 Special Topics in General Physics. (1-4) Prerequisite, consent of instructor. Credit according to work done.

PHYS 809 Special Topics in General Physics. (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 deHass-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 Solid 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 PHYS 751. 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)

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, Heath
Assistant Professors: Carter, Coon, Kuenzel, 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[2], Magoon[1], Martin, McIntyre, D. Mills, J. Mills, Pumroy[1], Scholnick, Steinman, Taylor, Tyler, Waldrop
Associate Professors: Brown, Dachler, Dies, Freeman[1], Gelso[1], Larkin, McKenzie[1], Pavey, Schneider, Sigall, Smith, Sternheim, Teitelbaum, Ward
Assistant Professors: Barrett, Carroll, Claiborn, Coursey, Gatz, Hill, Holmgren, Johnson, Meltzer, Osterhouse, Spector, Tanney

[1]Joint appointment with Counseling and Personnel Services
[2]Joint appointment with Business and Management

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 preception. 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 ac-

cessible 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 one-hour laboratory periods per week. Prerequisites: PSYC 200 and either 206 or 301. 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 206 or 301. 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 206 or 301. 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 two-hour laboratory/demonstration period per week. Prerequisite, MATH 140 or 111 and 220. Primarily for students who major in psychology. A systematic survey of the content, models, and methodologies of sensory and perceptual research. A student who has completed PSYC 310 must have permission of the instructor in order to register for PSYC 410.

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 Processes. (4) Prerequisite, PSYC 200 and 221. Primarily for psychology majors. A laboratory course which provides a basic understanding of experimental method in social psychology and experience in conducting research on social processes.

PSYC 422 Language and Social Communcation. (3) Prerequisite, PSYC 420. The nature and significance of verbal and nonverbal communcation 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, 200, and 400 or 410 or 420. The nature, diagnosis, etiology, and treatment of mental disorders. A student may not receive credit for both PSYC 331 and 431.

PSYC 433 Advanced Topics in Child Psychology. (3) Prerequisite, PSYC 200, 335. 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, 331, and 400 or 410 or 420. 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 451; either PSYC 431 or 435; and either PSYC 400 or 410 or 420. A survey and critical analysis of clinical psychology, with particular emphasis on current developments and trends. Designed to broaden the student's perspective on clinical psychology, to increase his intrinsic interest in the field, and to provide him with a firmer basis for critical evaluation of major theoretical and methodological foundations in the field. Students will be expected to conduct individual projects related to the course with a substantial amount of direct supervision.

PSYC 440 Introduction to Cognitive Psychology. (3) Prerequisite, PSYC 200. This course serves as an introduction to selected topics and theories in cognitive psychology. Topics include visual and auditory information processing, attention, memory, concept identification and psycholinguistics.

PSYC 441 Psychology of Human Learning. (3) Prerequisite, PSYC 200 and 440 or 410 or 420. 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. (4) Three lectures and one two-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 200. 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 on-going 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 Advanced Psychology I (Honors). (3) H—Honors. 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 Advanced Psychology II (Honors). (3) H—Honors. Usually taken during senior year. Prerequisite, PSYC 488H. Semester covering topics in measurement, social processes and other subject matter of current interest.

PSYC 499 Honors Thesis Research. (3) H—Honors. Usually taken during last semester in residence. Prerequisite: permission of thesis advisor.

PSYC 601 Quantitative Methods. (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 602 Quantitative Methods. (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 640 Fundamentals of Social Psychology. (3) Method, research and theory in social psychology.

PSYC 651 Sensory and Perceptual Processes. (3) A broad coverage of knowledge of sensory and perceptual processes. Major theories and antecedents of contemporary research in the field.

PSYC 661 Advanced General Psychology. (3)

PSYC 671 Verbal Behavior. (3) A systematic review of major topic areas in the general field of human learning with particular emphasis upon learning, memory, and linguistic processes.

PSYC 678 Seminar in Psycholinguistics. (3) Prerequisite, PSYC 671. Contemporary psycholinguistic theories of language acquisition and use Phonological, semantic and syntactic aspects of language Repeatable to a maximum of six credits.

PSYC 679 Seminar in Cognitive Development. (3) Prerequisite, PSYC 611 or 671. Advanced coverage of research methodology and research issues in various areas of cognitive development such as discrimination learning, concept identification, form perception, language acquisition, and memory Emphasis on interrelationships among developmental changes during infancy and childhood Utility of a developmental perspective in analyzing the components of cognition. Repeatable to a maximum of six credits.

PSYC 687 Historical Viewpoints and Current Theories in Psychology. (3) Prerequisite, PSYC 622.

PSYC 688 Historical Viewpoints and Current Theories in Psychology. (3)

PSYC 701 Multivariate Analysis I. (3) Prerequisite, PSYC 602 or permission 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) Prerequisites, 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 science—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) Prerequisite, consent of instructor. PSYC 721 and 722 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 722 Seminar and Laboratory in Behavioral Assessment I. (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. 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 723 Seminar and Laboratory in Behavioral Assessment II. (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 724 Seminar and Laboratory in Behavioral Assessment II. (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 engineering, 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 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. Emphasizes 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 performances, 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 communcations, 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 Social Psychology Research Methodology. (3) A review of research methodology in social psychology, including research design, techniques of data collection, and the interpretation of data. Emphasis is placed on developing skill in evaluating studies and generating research designs.

PSYC 741 Attitude Change. (3) A review of research and theory concerning the nature of attitudes and the determinants of attitude change.

PSYC 742 Group Behavior. (3) A review of research and theory concerning group behavior, including topics such as problem solving, communication, leadership and conformity.

PSYC 743 Person Perception. (3) A review of research and theory concerning the attribution of personal characteristics, interpersonal attraction and self-evaluation.

PSYC 748 Seminar in Social Psychology. (3) A seminar on selected topics in social psychology. Repeatable to a maximum of six credits.

PSYC 749 Current Research in Social Psychology. (1-3) Repeatable to a maximum of 9 credits.

PSYC 758 Seminar in Vision. (3) Prerequisite, PSYC 651 or consent of instructor. Selected topics in vision. Repeatable to a maximum of six credits.

PSYC 759 Seminar in Auditory Mechanisms. (3) Prerequisite, PSYC 651 or consent of instructor. Selected topics in auditory and psychoacoustic research, with emphasis on sensory and perceptual phenomena and their physiological bases. Repeatable to a maximum of six credits.

PSYC 761 Advanced Laboratory Techniques. (1-3) Methodology of the automatization or 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) Alternate years.

PSYC 764 Comparative Neuroanatomy. (3) Prerequisites, a graduate or undergraduate course in physiological psychology or physiology or comparative anatomy or permission of instructor. Demonstrations and lectures on the gross, microscopic and ultrastructural morphology of the central nervous system of vertebrates.

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 766 Laboratory Methods in Neuroanatomy. (3) Permission of the instructor. Laboratory practice in the perfusion and fixation of neural tissue. Training in the use of the compound microscope, the microprojector, the reconstruction of brain lesions and macro- and microphotography of neural tissue.

PSYC 768 Conditioning and Learning. (3) Alternate years Prerequisite, PSYC 622 The literature on the experimental analysis of behavior, with examination of basic experiments and contemporary theories related to them

PSYC 778 Seminar in Learning and Memory. (3) Prerequisite, PSYC 671. An advanced topical seminar covering the areas of human learning and memory. Acquisition processes, storage and retrieval processes, and attention and information processing Repeatable to a maximum of six credits

PSYC 788 Special Research Problems. (1-4) Supervised research on problems selected from the area of experimental, industrial, social, quantitative, or mental health psychology

PSYC 789 Special Research Problems. (2)

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. (3) An advanced seminar covering specialized topics Repeatable to a maximum of nine credits.

PSYC 858 Contemporary Theories in Sensory Processes. (3) Prerequisites, PSYC 651 or consent of instructor. Specialized study of sensory processes with emphasis on mathematical models. Repeatable to a maximum of six credits.

PSYC 859 Special Topics in Perception. (3) Prerequisites, PSYC 651 or consent of instructor. Intensive study of selected topics in perception. Repeatable to a maximum of six credits.

PSYC 878 Current Research in Language and Cognition. (3) Prerequisite, PSYC 671. Seminar will cover current research and methodological issues in language and cognition. Specialized topics include: computer models of cognitive behavior; cross-cultural studies in language and thought; mathematical and analytical techniques for assessing structures; and others. Repeatable to a maximum of six credits.

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
Assistant Professor: Thompson

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 course work 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 governmental recreation programs and their planning (with particular emphasis on playground, community and teen center plans and procedures). Observations will be required.

RECR 426 Industrial Employee 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 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 public relationships. The group work approach will be emphasized and used, insofar as possible, in the solution of particular problems that grow out of required field experiences in handling on or off campus groups.

RECR 463 Supervisory Techniques in Recreation. (3) A study of the principles, methods, 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 Institutional 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 Recreation Areas and Facilities. (3) Studies 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 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 or 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 Masters Thesis Research. (1-6)

RECR 899 Doctoral Dissertation Research. (1-8)

Secondary Education Program

Professor and Chairman: Risinger
Professors: Campbell, Gardner[1], Grambs, Lockard[3], Taylor[2], Walbesser, Woolf
Associate Professors: Adkins, Anderson, Brigham, Carr, Davidson, Farrell[4], Fey[5], Funaro, Green, Henkelman[5], Lemmon[6], Longley, Love[7], McWhinnie[8], Peters
Assistant Professors: Baird, Church[7], Cirrincione[9], Davey, DeLorenzo[10], James[12], Layman[11], Pfister[13], Ricci, Ridky[14], Ruchkin
Lecturer: Auston

[1]joint appointment with Chemistry
[3]joint appointment with Music

[3]joint appointment with Botany
[4]joint appointment with History
[5]joint appointment with Mathematics
[6]joint appointment with Family & Community Development
[7]joint appointment with Physical Education
[8]joint appointment with Housing & Applied Design
[9]joint appointment with Geography
[10]joint appointment with Spanish & Portuguese
[11]joint appointment with Physics
[12]joint appointment with English
[13]joint appointment with Germanic & Slavic
[14]joint appointment with Geology

The Department of Secondary Education offers programs leading to the Master of Arts (both thesis and non-thesis options), Master of Education, the Advanced Graduate Specialist, the Doctor of Philosophy, and the 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.

The master's degree programs require from 30 to 36 semester hours, the AGS a program of sixty hours beyond the bachelor's degree, and the doctorate requires a planned sequence of approximately 60 semester hours beyond the master's degree. There are no foreign language requirements unless the dissertation is on a topic that requires it. Entrance for the doctoral program requires a master's degree, an acceptable Miller's Analogy score, and a good scholastic record. A preliminary examination is given at the end of 20 semester hours of doctoral work and a comprehensive examination at the conclusion of the course work. Approximately ten percent of the graduate students in the department are receiving financial aid.

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; 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 of 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 basis 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) Prerequisite, EDSE 453 or equivalent. For teachers, supervisors, and administrators who wish to identify and assist pupils with reading difficulties. Concerned with diagnostic techniques, insturctional materials and teaching procedures useful in the regular classroom.

EDSE 431 Laboratory Practices in Reading. (2-4) Prerequisite, EDSE 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.

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 two-hour lecture discussion period and two, two-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 and 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 three 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 488 Special Topics in Secondary Education. (1-3) Repeatable for a maximum of 6 hours.

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 Administrative 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; occupational 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 qualitative 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) 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 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) A survey of the research literature; evaluation of research techniques; consideration of relevant instructional curriculum theory; evaluation of modern teaching methods and techniques.

EDSE 742 Theory and Research in Secondary Education—Business. (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 743 Theory and Research in Secondary Education—Distributive Education. (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 744 Theory and Research in Secondary Education—English. (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 745 Theory and Research in Secondary Education—Foreign Language. (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 746 Theory and Research in Secondary Education—Home Economics. (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 747 Theory and Research in Secondary Education—Mathematics. (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 750 Theory and Research in Secondary Education—Music. (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 751 Theory and Research in Secondary Education—Reading. (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 752 Theory and Research in Secondary Education—Science. (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 753 Theory and Research in Secondary Education—Social Studies. (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 754 Theory and Research in Secondary Education— Speech. (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 755 Theory and Research in Secondary Education—Urban Education. (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 788 Special Topics in Secondary Education. (1-3) Prerequisite, EDSE 640 appropriate to area of concentration, or consent of instructor. Repeatable to a maximum of 6 hours.

EDSE 798 Special Problems in Education. (1-6) Master's, AGE, or doctoral candidates who desire to pursue special research problems under the direction of their advisors may register for credit under this number.

EDSE 799 Master's Thesis Research. (1-6) Registration required to the extent of six hours 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 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 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 elibigle: (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 EDSE 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSE 899 Doctoral Dissertation Research. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Social Foundations of Education Program

Associate Professor and Acting Chairman: Noll
Professor: Male
Associate Professors: Agre, Hopkins, Huden, Lindsay
Assistant Professor: Finkelstein

The objectives of the doctoral 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 opportunities for related course work in either history, philosophy, government and politics, anthropology, or sociology. Programs are tailored to a student's objectives and background.

The master's program offers a non-thesis option (30 hours) and a thesis option (24 hours). Graduates of the master's program find positions in research or policy units in public school systems or in educational organizations. Some graduates are qualified for positions in community agencies or in programs with an educational component, such as an anti-poverty program. Some take positions with international organizations dealing with education or teach in schools located in other countries.

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. Students in the doctoral program take a preliminary examination (6 hours in length) after they have completed between 12 and 18 hours of course work.

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 Social Foundations of Education. (1-3) Repeatable to a maximum of nine hours. 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.

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 non-major students. Note: The total number of credits which a student may earn in EDSF 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 620 Analysis of Educational Concepts. (3)

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 Organizations 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) Registration required to the extent of 6 hours 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 EDSF 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 EDSF 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSF 899 Doctoral Dissertation Research. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Sociology Program

Professor and Chairman: Kammeyer
Professors: Dager, Janes, Ritzer
Associate Professors: Cussler, Henkel, Hirzel, Lengermann, McIntyre, Meeker, Pease
Assistant Professors: Braddock, Finsterbusch, Franz, Greisman, Harper, Hornung, J. Hunt, L. Hunt, Kruegel, Landry, Mayes, Miller, Schwartz, Segal

The graduate program in Sociology offers course-work 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 consulation 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. The three areas may be two specializations and a general examination in either Social Psychology, or Social Organization, or they may be general examinations in both Social Psychology and Social Organization and one 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 nonparametric techniques, additional topics in inferential statistics. Required of all candidates for the M.A. degree.

SOCY 410 Population I. (3) Prerequisite, junior standing; SOCY 100 not required. Population distribution and growth; sources of demographic data; population composition; population theories; mortality; fertility and family planning; migration; and population problems and policy.

SOCY 411 Population II. (3) Prerequisite, SOCY 410 and 201 or equivalent statistical training. Application of statistical techniques employed in the analysis of census and vital statistics data, including methods of population standardization, life table construction, and use of computerized demographic data.

SOCY 421 Intercultural Sociology. (3) Prerequisite, SOCY 100. 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. 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. Race as a focus of social relations. Political and collective action centering on race relations. New myths of race. Trends in assimilation of racial groupings.

SOCY 425 Sex Roles and Social Institutions. (3) Prerequisite, 12 credits in sociology. Relationship between sex roles and the structure of one or more social institutions (e.g., the economy, the family, the political system, religion, education). The issues of major concern are: how assumptions about sex roles are built into social institutions; how social institutions serve to perpetuate or transform sex roles; how changing sex roles affect social institutions.

SOCY 426 Sociology of Religion. (3) Prerequisite, SOCY 100. Varieties and sources of religious experience. Religious institutions and the role of religion in social life.

SOCY 427 Deviant Behavior. (3) Prerequisite, SOCY 100. 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. 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. 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. 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, mechanism, 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 the 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) Prerequisites, sociology 100 and 201 (sociological statistics) or equivalent. Analysis of small group structures and dynamics. Review of research on small groups in real life settings and in laboratories. Presentation of techniques used in small groups.

SOCY 457 Sociology of Law. (3) Prerequisite, SOCY 100. 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. 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. The sociology of human relations in American industry and business. Complex industrial and business organization as social systems. Social relationships within and between industry, business, community, and society.

SOCY 464 Military Sociology. (3) Prerequisite, SOCY 100. Social change and the growth of military institutions. Complex formal military organizations. Military service as an occupation or profession. The sociology of military life. Relations between military institutions, civilian communities and society.

SOCY 465 The Sociology of War. (3) Prerequisite, SOCY 100. The origin and development of armed forces as institutions, the social causes, operations and results of war as social conflict; the relations of peace and war and revolution in contemporary civilizations.

SOCY 466 Sociology of Politics. (3) Prerequisite, 9 credits in sociology. An introduction to the sociology of political phenomena. Consdieration of the basic concepts and major findings in the field; the relationship of the policy to other institutional orders of the society; the relationship of political activity in America to the theory of democracy.

SOCY 467 Sociology of Education. (3) Prerequisites, SOCY 100 or permission of the instructor. Listed also as EDSF 430. Sociological analysis of educational institutions and their relation to society: goals and functions, the mechanisms of social control, and the impacts of stratification and social change. Study of the school as a formal organization, and the roles and subcultures of teachers and students.

SOCY 470 Rural-Urban Relations. (3) Prerequisite, SOCY 100. 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. 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. 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. 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. Local 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 of 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 012, 020 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 400 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 400 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 to 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 college behavior, and art manifestations of societal values of various countries.

SOCY 632 Personality and Social Structure. (3) First semester. Comparative analysis of the development of human nature, personality, and social traits in select social structures.

SOCY 633 Sociology of Occupations and Professions. (3) Second semester. 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) Second semester. Process involved in the formation of mass attitudes; agencies and techniques of communication; quantitative measurement of public opinion.

SOCY 635 Sociology of Law. (3)

SOCY 640 Social Change and Social Policy. (3) First semester. 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) Second semester. Case studies of family situations; statistical studies of family trends, methods of investigation and analysis.

SOCY 642 The Sociology of Mental Health. (3) First semester. 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) First semester. 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 of equivalent. A critical examination of the major theoretical approaches developed for understanding 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, McCleland, Ossowski, Sorokin, Toennies, and Veblin, 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 causal 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 non-response; 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 and Portuguese Language and Literature Program

Professor and Chairman: Mendeloff
Professors: Goodwyn, Gramberg, Hesse, Marra-Lopex, Nemes
Associate Professors: Rovner, Sosnowski
Assistant Professors: Baird[1], Natella

[1]Joint appointment with Secondary Education

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. Financial assistance is available.

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. All M.A. candidates take comprehensive exams.

As in the M.A. program, the doctoral student may work in either the Spanish or the Spanish-American area. In addition to his specialized knowledge of his chosen field, he will be expected to have a thorough acquaintance with the whole area of his choice. This acquaintance will be demonstrated through a written comprehensive examination plus individually specified courses.

The Ph.D. is primarily a research degree. Courses taken for the Ph.D. are intended as 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.

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.

SPAN 401 Advanced Composition. (3) Exercises in practical stylistics, with special emphasis on idiomatic and syntactic structures. Graduate credit in the College of Education only.

SPAN 402 Advanced Composition. (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 current sentence structure, pronunciation and idiomatic expression. Graduate credit in College of Education only.

SPAN 408 Great Themes of the Hispanic Literatures. (3) Pervading themes in the literature of Spain or Spanish-America. Each theme will be announced when the course is offered.

SPAN 409 Great Themes of the Hispanic Literatures. (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 Prose and Poetry of the Sixteenth Century. (3) Selected readings and literary analysis.

SPAN 421 Prose and Poetry of the Sixteenth Century. (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 Spanish Civilization. (3) A survey of two thousand years of Spanish history, outlining the cultural heritage 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 426 Spanish Civilization. (3) A survey of two thousand years of Spanish history, outlining the cultural heritage 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 Cervantes—Novelas Ejemplares and Don Quixote. (3)

SPAN 431 Cervantes—Novelas Ejemplares and Don Quixote. (3)

SPAN 434 Prose and Poetry of the Seventeenth Century. (3) Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background.

SPAN 435 Prose and Poetry of the Seventeenth Century. (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) 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 Literature of the Eighteenth Century. (3) Traditionalism, neo-classicism, and pre-romanticism in prose, poetry, and the theater; esthetics and poetics of the enlightenment.

SPAN 441 Literature of the Eighteenth Century. (3) Traditionalism, neo-classicism, and pre-romanticism in prose, poetry, and the theater; esthetics and poetics of the enlightenment.

SPAN 446 Latin-American Civilization. (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 447 Latin-American Civilization. (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 The Generation of 1898 and its successors. (3) Authors and works of all genres of the generation of 1898 and those of the immediately succeeding generation.

SPAN 461 The Generation of 1898 and its Successors. (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 Modernism and Post-Modernism in Spain and Spanish-America. (3) A study of the most important works and authors of both movements in Spain and Spanish-America.

SPAN 469 Modernism and Post-Modernism in Spain and Spanish-America. (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-political 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 Spanish-American Fiction. (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 489 Spanish-American Fiction. (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 Honors Reading Course—Poetry. (3) H—Honors. Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 492 Honors Reading Course—Novel. (3) H—Honors. Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 493 Honors Reading Course—Drama. (3) H—Honors. Supervised reading to be taken by students admitted to the honors program or upon consultation with the instructor.

SPAN 496 Honors Seminar. (3) H—Honors. 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. (3)

SPAN 601 Reading Course for Minors in Spanish. (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, demonstration, and classroom practice under supervision of modern procedures in the presentation of first year Spanish.

SPAN 608 Medieval Spanish Literature. (3) Specific authors, genres, and literary periods studied in depth.

SPAN 609 Medieval Spanish Literature. (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 Poetry of the Golden Age. (3) Analyses and studies in depth of specific works of specific poets in the sixteenth and seventeenth centuries.

SPAN 619 Poetry of the Golden Age. (3) Analyses and studies in depth of specific works of specific poets in the sixteenth and seventeenth centuries.

SPAN 628 Seminar—The Golden Age in Spanish Literature. (3)

SPAN 629 Seminar—The Golden Age in Spanish Literature. (3) Specific authors, genres, literary movements and literary periods of the sixteenth and seventeenth centuries studied in depth.

SPAN 699 Independent Study in Spanish. (1-3) This course is designed 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 The Eighteenth Century. (3) Specific authors, genres, and literary movements studied in depth.

SPAN 709 The Eighteenth Century. (3) Specific authors, genres, and literary movements studied in depth.

SPAN 718 The Nineteenth Century. (3) Specific authors, genres, and literary movements studied in depth.

SPAN 719 The Nineteenth Century. (3) Specific authors, genres, and literary movements studied in depth.

SPAN 728 The Twentieth Century. (3) Specific authors, genres and literary movements studied in depth.

SPAN 729 The Twentieth Century. (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 National Spanish-American Literature. (3) Characteristics of the national literatures. Romantic and costumbrisia literature. Cauchismo and indigenismo. Principal works and authors.

SPAN 819 National Spanish American Literature. (3) Characteristics of the national literatures. Romantic and costumbrisia literature. Cauchismo and indigenismo. Principal works and authors.

SPAN 828 Hispanic Poetry of the Nineteenth and Twentieth Centuries. (3) Specific authors, genres and literary movements studied in depth.

SPAN 829 Hispanic Poetry of the Nineteenth and Twentieth Centuries. (3) Specific authors, genres and literary movements studied in depth.

SPAN 898 Open Seminar. (3)

SPAN 899 Doctoral Dissertation Research. (1-8)

PORTUGUESE

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 for whom the literatures would be inaccessible in Portuguese. Repeatable to a maximum of six credits.

PORT 699 Independent Study of Portuguese. (1-3) This course is designed 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.

Special Education Program

Professor and Acting Chairman: Simms
Professor: Hebeler
Associate Professors: James (visiting), Seidman
Assistant Professors: Grief, McCabe

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 compentencies 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 must have completed the Master of Arts degree or the Master of

Education degree and may elect to work for either the Ed.D. of Ph.D. degree. Students should consult the Department Document on Admissions criteria. 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) Prerequisite, EDSP 288. 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 has 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 Problems. (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 epidemeology, 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 distrubed 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 EDSP 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 distrubed.

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 advisors may register for credit under this number.

EDSP 799 Master's Thesis Research. (1-6) Registration required to the extent of six hours for master's thesis.

EDSP 888 Apprenticeship in Special 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 Univesity 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 twenty (20) semester hours.

EDSP 889 Internship in Special 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 EDSP 489, 888, and 889 is limited to a maximum of twenty (20) semester hours.

EDSP 899 Doctoral Dissertation Research. (1-8) Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation.

Speech and Dramatic Art Program

Professor and Chairman: Aylward
Professors: Meersman, Pugliese
Associate Professors: Kirkley, Linkon, O'Leary, Vaughan, Weiss, Wolvin
Assistant Professors: Falcione, Freimuth, Jamieson, Kolker, Moore, Onder
Lecturer: Niles

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, at least one formal research paper and comprehensive examinations are required in the non-thesis option.

For admission to the graduate program in any of the three divisions an applicant must ordinarily meet the following requirements: 1) a bachelor's degree from an accredited institution with an overall academic average of B; 2) at least eighteen semester hours of course work or equivalent professional experience in his/her intended major area of concentration; 3) acceptable scores on the Graduate Record Examination. Approximately forty-five percent of the full time students currently enrolled in the graduate program of the department receive some form of financial assistance.

Specific information regarding the programs and requirements of the three divisions is available from the Department Chairman upon request. Abbreviated information appears below under the individual division headings.

The department cooperates with the Department of Secondary Education in offering the Doctor of Philosophy degree in Speech Education.

Dramatic Art

Although there are no formal divisions within the Division of Dramatic Art, the student may pursue a general program or specialize in one area of concentration. In addition to acting, exceptionally talented students are given the opportunity to direct and design scenery, lights, costumes for mainstage productions. Ample opportunities are also provided for the artistic development of the students in the many theatres associated with the Theatre Division. The Division of Dramatic Art offers both the research thesis and the production thesis. Before electing a production thesis, a student must demonstrate proficiency in his/her chosen area of concentration.

Radio-Television-Film

A student in the Radio-Television-Film Division may concentrate either in a particular area (film or broadcasting, for example) or may elect a more general program covering the multiple aspects of electronic and film communication. A student whose academic goals extend beyond the Radio-Television-Film Division may, upon approval of his advisor, take as many as twelve credit hours in cognate fields in other divisions or in other departments of the University. Examples of such programs would include educational uses of media, broadcast management or electronic journalism.

Students electing the thesis option may either pursue a traditional research thesis or complete a production thesis. Before a production thesis will be approved the student must demonstrate his ability to complete such a project through the submission of a portfolio or equivalent evidence.

Speech Communication

Students who elect to pursue a program of study in the Division of Speech Communication are encouraged to develop programs reflecting an understanding of the genesis, the nature and the effects of human speech behavior. A student may concentrate within a specialized area of Speech Communication (Political Communication or Organizational Communication, for example) or may elect a more general course of study. Students in the Speech Communication Division are urged to augment their program of study with coursework in complementary disciplines.

Dramatic Art

DART 420 Style 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 production on the elementary school level. Major emphasis on creative dramatics, the application of creative dramatics in the school room, 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.A—For dramatic art majors only

DART 451 Advanced Scenic Design. (3) Prerequisite DART 330, 375, 475, 480 or permission of instructor. Design of stage settings, and of one total production. Study of stage design on 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. (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)

Radio, Television and Film

RIVF 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, Grifith, 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: RIVF 314.

RIVF 414 Contemporary American Cinema. (3) Prerequisite, RIVF 222. An analysis of the 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 verity motion pictures.

RIVF 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.

RIVF 417 Dramatic Writing for Broadcasting and Film. (3) Prerequisite, RIVF 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.

RIVF 418 The Film Autheur. (3) The intensive chronological study of the work of one European or American film director each semester.

RIVF 419 Film Genres. (3) The study of one major film genre each semester (the gangster film, the western, science fiction and horror, the political film). Cinema develops formal and thematic conventions and how, as a medium for reflecting social ideals and needs. Repeatable to a maximum of six credits.

RIVF 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.

RIVF 421 Film Criticism and Theory. (3) Critical-aesthetic approaches to film in order to develop a vocabulary for film analysis. Included will be shot analysis; montage and deep focus; the auteur theory; the role of screenwriter, director of photography, actor; genre analysis; analysis of film as popular art.

RIVF 425 Television and Politics. (3) Critical review of studies of the effects of political broadcasts; legal and social issues; surveys and media campaigns.

RIVF 440 Television Direction. (3) Two hour lecture, two hour laboratory. Prerequisite, RIVF 340. Principles of television direction, including analysis of script, casting, rehearsing, production, audio and video control.

RIVF 449 Television Workshop. (3) Two-hour lecture, four-hour laboratory. Prerequisites, RIVF 340, 440 and consent of instructor.

RIVF 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.

RIVF 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.

RIVF 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.

RIVF 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.

RIVF 465 Advanced Film Production. (3) Prerequisite, RIVF 355 and consent of instructor. Consideration of film technique and theory as they apply to the making of a full length motion picture.

RIVF 498 Seminar. (3) Prerequisites, senior standing and consent of instructor. Present day radio-television-film research. Repeatable to a maximum of six credits.

RIVF 600 Introduction to Graduate Study in Broadcasting. (3)

RIVF 640 Advanced Television Direction. (3) Prerequisite, RATV 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.

RIVF 648 Seminar in Broadcasting. (3) Studies of various aspects of broadcasting Subject matter changed each semester.

RIVF 649 Special Problems in Broadcasting. (3) An experimental course for the development of new ideas in broadcasting

RIVF 699 Independent Study. (1-3)

RIVF 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, Quintlian, 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, Speech 200 or consent of the instructor. Course examines the rhetorical development of major historical movements and influential spokesmen from 1636-1900. 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, Speech 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 Listening. (3) A study of the listening process, listening variables, listening levels, and the development of effective listening behavior.

SPCH 472 Nonverbal Communication. (3) Survey of nonverbal communication in human interaction; theory and research on proxemics, kinesics and paralinguistics as expression of relationship, affect and orientation within and across cultures.

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 477 Speech Communication and the Study of Language Acquisition. (3) Survey of language acquisition and development in human communication behavior; theory and research on language structure, syntactic, phonological, and cognitive systems as an influence of an individual's orientation and development within and across cultures.

SPCH 478 Speech Communication Colloquium. (1) Current trends and issues in the field of speech communication, stressing recent research methods. Recommended for senior and graduate student majors and minors in speech communication. Repeatable to a maximum of 4 hours.

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 Honors Seminar. (3) For honors students only. 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 Communication Programs in Education and Training. (3) An analysis of speech communication techniques in a variety of educational and training programs.

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) Second semester. 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)

Textiles and Consumer Economics Program

Professor and Chairman: Smith
Professor: Dardis
Visiting Professor: Fourt
Associate Professor: Buck, Spivak
Visiting Associate Professor: Clark
Assistant Professors: Hacklander, Yeh
Visiting Assistant Professor: Block

The Department of Textiles and Consumer Economics offers graduate work leading to the Master of Science degree in either the thesis or the non-thesis 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 of 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)- Spring semester. 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 spending 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 488 Senior Honors Thesis. (1-4)- Limited to undergraduate students in the departmental honors program. An independent literary, laboratory or field study, conducted throughout the student's senior year. Student should register in both fall and spring.

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 three-hour laboratory periods per week. Prerequisites, APDS 101 and TEXT 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 three-hour laboratory periods per week. Prerequisites, APDS 101, TEXT 250, and TEXT 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 and 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 frameworks 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 various 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 culture of man.

TEXT 452 Textile Science—Chemical Structures and Properties of Fibers. (3) Two lectures and one three-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 three-hour laboratory per week. Prerequisite, TEXT 452 or consent of instructor. A study of the chemical reactions and mechanisms involved in imparting water repellance, 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 effect its end-use will 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 three-hour laboratory per week. Prerequisite, consent of instructor. The 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 488 Senior Honors Thesis. (1-4) Limited to undergraduate students in the departmental honors program. An independent literary, laboratory or field study, conducted throughout the student's senior year. Student should register in both fall and spring.

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)

Institute for Urban Studies Program

Professor and Director: Murphy
Professors: Janes, Kidd, Harper
Assistant Professors: Florestano, Christian
Instructors: Taubald, Knipe
Lecturer: Russell

The Institute for Urban Studies offers a program leading to a degree in the Master of Arts in Urban Studies. The principal aim of the M.A. program is to educate students both in the technical competencies involved in urban problem solving and in an interdisciplinary understanding of the urban community. A graduate of the program would be prepared for a career in governmental, non-profit or business activities relating to urban service, delivery, governance, or policy analysis. Graduates would also be eligible for pursuing doctoral degrees in the discipline selected for specialized study or in interdisciplinary urban studies and policy analysis programs.

Both a thesis and non-thesis option are available for the M.A. degree. The thesis option calls for a minimum of twenty-four (24) credit hours of course work in addition to a thesis. Twelve (12) hours of course work must be in core courses and a minimum of nine (9) hours in an area of specialization. The non-thesis option calls for a minimum of thirty (30) hours of course work including fifteen (15) hours of work in core courses and fifteen (15) hours of work in an urban specialization.

Both options require successful completion of a two-part comprehensive examination. The first part, on basic urban studies knowledge, will be administered by the Institute. The second part will be administered by the department the student selects for an urban specialization.

1. Thesis Option

   a) core courses required for the thesis option include Urban Studies 601, Urban Studies 610, Urban Studies 640, and Urban Studies 680.

   b) a minimum of nine (9) credit hours must be taken in one of the departments or programs listed in D, Departmental Specializations.

   c) an additional three credit hours must be taken from the Institute, the department offering the specialization, or from other departments with urban courses.

   d) at least fifteen (15) hours of course work for the M.A. degree with thesis option must be at the 600 level.

2. The Non-Thesis Option

   a) the non-thesis option requires successful completion of Urban Studies 601, 610, 640, and 680 as well as three (3) credit hours in any other course offered for graduate credit by the Institute.

b) Fifteen (15) credit hours must be taken in one of the departments or programs listed in "Departmental Specializations" or, in special circumstances, in one of three cross-departmental areas of urban emphasis. The three areas which may be elected for a specialization are 1) physical science, engineering, and environmental 2) humanities-historical, and 3) social-behavioral dimensions of urban studies. If a cross-departmental specialization is selected, the Institute will administer both portions of the comprehensive examination.

c) At least twenty-one (21) credit hours of the course work for the M.A. degree with non-thesis option must be at the 600 level.

Departmental Specializations

Departments which are likely to have enough urban-oriented courses to provide an area of specialization are listed below. All required hours of work need not be directly related to urban affairs. For example, the supporting specialization might include a course in theory or techniques of investigation within a particular discipline. The student's program of courses in his specialized area should be worked out in consultation with his advisor.

*Afro-American Studies
Agricultural and Extension Education
American Studies
*Architecture
*Business Administration
Chemical Engineering
Computer Science
*Criminal Justice and Criminology
*Economics
English
*Education
*Family and Community Development
*Geography
*Government and Politics
*Health
*History
*Information Systems Mangement
*Journalism
Meteorology
Physical Education
*Psychology
Recreation
*Sociology
Speech and Communications

*Departments at College Park campus already having sufficient graduate or upper division courses to provide a specialization

A very limited number of graduate research and teaching assistant positions are available. Applications should be filed prior to May 1st. The GRE is generally required for any student whose grade point average is less than 3.00

URBS 430 Practicum in the Urban Community and Urban Organizations. (3) Supervised field training in urban-oriented programs. Emphasized areas of interest are (1) neighborhoods and communities (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 emphases—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 Studies. (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. (1-6)

Zoology Program

Professor and Chairman: Corliss
Professors: Asastos, Brinkley, Brown, Clark, Grollman, Haley, Highton, Jachowski, Schleidt
Associate Professors: Barnett, Contrera, Goode, Imberski, Levitan, Linder, Morse, Pierce, Potter, Small, Vermeij
Assistant Professors: Allan, Gill, Higgins, Morton, Rees, Woodin
Research Associate Professor: Eisenberg

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.

The Ph.D. program in Zoology is basically a research program providing maximal opportunity for the student to evolve and develop his innate capacity for scholarship and independent work. A doctoral candidate must register for a minimum of 12 semester hours of doctoral research (899). Opportunity is provided for in-depth study in an area of specialization. A formal preliminary examination is given to all doctoral students within the first two years of enrollment in the department. The examination is basically an oral examination focusing primarily on determination of whether or not the student has the proper motivation, intellectual capacity and curiosity, and educational background and has or can develop the technical skills to successfully pursue the Ph.D. program. However, there is no formal restriction on the extent or the range of the questions asked of the candidate. The doctoral dissertation must be completed and defended usually within three, preferably two years, after passing of prelims.

The thesis master's program enables a student to engage in advance study and to undertake a research project. It may be a terminal degree or may demonstrate the student's research ability and lead to continuation of graduate work for the Ph.D. in the same or related area. Completion of 30 credits of which 6 must be thesis research (799) is required. Of the 24 hours of course work, no fewer than 12 hours must be at the 600 level or above. Twelve credit hours must be in the major subject. All requirements for the master's degree are to be completed within a three year period. A final oral examination on the thesis is given whenever the student has completed all other requirements for the degree.

The non-thesis master's program provides opportunity for advanced education and a terminal degree for those who are not research oriented. All non-thesis master's students are required to complete no fewer than 30 hours of course work with an average grade of "B". Of these 30 hours, no fewer than 18 must be at the 600 level or above in Zoology or appropriate related fields. No fewer than 16 hours of courses must be in Zoology and three of these courses should be in a single area of specialization. In addition, it is expected that at least one satisfactory scholarly paper be written in an area approved by the student's advisor and that a written comprehensive examination in three areas of Zoology be passed. All requirements must be completed within a three year period.

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, Maryland 20742

ZOOL 411 Cell Biology. (4) Two hours of lecture, one hour of demonstration-discussion and three hours of laboratory per week. Prerequisites, two years of zoology and 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 mechnaisms of coordination and control of cell function.

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.

ZOOL 415 Cell Differentiation. (3) Three hours of lecture per week. Prerequisites, a course in development biology, cell biology, molecular genetics or permission of instructor. Cellular and subcellular differentiation, emphasizing the biochemical and ultrastructural bases of these development changes.

ZOOL 421 Physiology of Excitable Cells. (4) Three hours of lecture and three hours of laboratory per week. Prerequisites, an introductory course in zoology or biology; a semester of organic chemistry; physics, through an introduction to electricity and magnetism; MATH 110 or 115. The physiology of nerves, muscles and sensory receptors and aspects of central nervous system physiology.

ZOOL 422 Vertebrate Physiology. (4) Three hours of lecture and three hours of laboratory per week. Prerequisites, one year of zoology and one semester of organic chemistry. A study of the cardiovascular, hemopoietic, gastro-intestinal, renal and respiratory systems. Chemical and endocrine regulation of physiological functions in higher vertebrates with emphasis on mammals.

ZOOL 426 General Endocrinology. (3) Three hours of lecture per week. Prerequisites. Three semesters of animal biology and two semesters of organic chemistry. Functions and the functioning of the endocrine glands of animals with special reference to the vertebrates.

ZOOL 430 Vertebrate Embryology. (4) Two hours of lecture and six hours of laboratory per week. Prerequisite, one year of biology or zoology. Vertebrate embryogenesis, developmental physiology and experimental embryology.

ZOOL 440 Evolution. (3) Three hours of lecture per week. Prerequisites, a course in genetics and a course in animal diversity. A consideration of current thought in regard to the evolution of living organisms.

ZOOL 444 Advanced Evolutionary Biology. (3) Three hours of lecture per week. Prerequisites, ZOOL 440 or equivalent; one semester of calculus. The nature and consequences of organic evolution in relation to present day geography and geologic time. Topics covered will include organic diversity gradients in space and time, rates of evolution, co-evolution and extinctions. Particular emphasis will be placed on the synthesis of information and on construction and evaluation of hypotheses.

ZOOL 446 Molecular Genetics. (3) Three hours of lecture per week. Prerequisites, ZOOL 246 or equivalent and a course in organic chemistry. The molecular basis of gene structure and function. Regulation of differential gene expression.

ZOOL 447 Experimental Genetics. (4) Two hours of lecture and six hours of laboratory per 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 hours of lecture per week. Prerequisites, a course in general zoology or equivalent and a course, or current enrollment in, physiology or ecology. 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 hour of lecture and six hours of laboratory 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 hours of lecture per week. Prerequisites, one year of zoology, a course in calculus and a course in statistics. A course in genetics is strongly recommended. Designed for majors and graduate students in the biological sciences. Topics to include theory of population growth and regulation, life tables and population projection matrices, Niche theory, theory of competition and predation, diversity analysis, and energetic modeling. Emphasis will be on current literature and research in ecological theory.

ZOOL 471 Laboratory and Field Ecology. (2) Three hours of laboratory and field work and one hour of discussion per week. Prerequisites, Zoology 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 Zoology 470. Terrestrial and equatic systems will be studied.

ZOOL 472 Protozoology. (4) Two hours of lecture and six hours of laboratory including field trips per week. Prerequisite, one year of biology. 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 habits.

ZOOL 475 General Parasitology. (4) Two hours of lecture and six hours of laboratory per week. Prerequisites, two years of zoology and one year of chemistry, or permission of the instructor. A consideration of the phenomenon of parasisism through a study of the structure, function and host relationships of parasitic organisms.

ZOOL 477 Symbiology. (2) Prerequisite, a course in animal diversity. Two lecture hours per week. An introduction to basic concepts of symbiosis. Adaptations for establishment of symbiotic associations, symbiote nutrition and metabolism, responses of the host and ecology of the host-symbiote complex.

ZOOL 480 Aquatic Biology. (4) Two hours of lecture and six hours of laboratory per week. Prerequisite, a course in animal diversity and a course in ecology. An investigation of the causal relationships of freshwater, estuarine and marine biotic communities to their environment.

ZOOL 481 The Biology of Marine and Estuarine Invertebrates. (4) Two hours of lecture and six hours of laboratory per 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.

ZOOL 482 Marine Vertebrate Zoology. (4) Two hours of lecture and six hours of laboratory per 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.

ZOOL 483 Vertebrate Zoology. (4) Two hours of lecture and four hours of laboratory per 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 considertation of the evolution of living and fossil representatives.

ZOOL 492 Form and Pattern in Organisms. (3) Prerequisites, one year of calculus; one year of physics; one semester of introductory biology. A lecture course in structural and functional interpretation of form in organisms. Pattern formation in morphogenesis, mathematical description of shape, methods, and examples of functional analysis of form, and patterns of morphological diversity through space and time.

ZOOL 495 Mammalian Histology. (4) Two hours of lecture and six hours of laboratory per week. Prerequisites, a course in vertebrate anatomy and a course in vertebrate physiology or permission of the instructor. A study of the microscopic anatomy, ultrastructure and histophysiology of tissues and organs of mammals.

ZOOL 608 Zoology Seminar. (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 & Marine Biology, D—Genetics, E—Parasitology, F—Physiology, G—Systematic & 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 & Marine Biology, D—Genetics, E—Parasitology, F—Physiology, G—Systematic & Evolutionary Biology, I—Behavior, J—Recent Advances, K—Endocrinology, L—Ecology.

ZOOL 610 Cellular 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 and 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.

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.

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.

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 chemistry 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.

ZOOL 625 Comparative Invertebrate Endocrinology. (3) Three lectures 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.

ZOOL 626 Mammalian Physiology. (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 survey of neurochemistry and neuropharmacology, the study of action of hormones and drugs at the molecular and cellular level.

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.

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.

ZOOL 630 Organogenesis. (2) Two lectures per week. Prerequisite, a course in embryology or departmental biology: the experimental basis of developmental mechanisms.

ZOOL 631 Biochemical Patterns in Development. (2) Prerequisites, a course in embryology and a course in physiology or biochemistry. Two lectures per week. The biochemical basis of development.

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 evolution.

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.

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.

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.

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.

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.

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.

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.

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 673 Advanced Aquatic Ecology. (4) Prerequisite, ZOOL 670 or equivalent. One discussion session (arranged) and one all-day laboratory per week. Emphasizes field experience in analyzing ecological processes in freshwater lakes and rivers, and the plankton communities of estuaries.

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 675 Ecological Models. (3) Three hours of lecture-discussion a week. Prerequisite, ZOOL 670 or equivalent. Explores the assumptions, structure and consequences of theoretical models in ecology.

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 organism and environment upon the dynamics and resource utilization of animals.

ZOOL 677 Ecology of Marine Communities. (4) Prerequisites, ZOOL 670 or permission of the instructor. ZOOL 481 strongly recommended. Two lecture-recitation periods and six hours of laboratory per week. An evaluation and extension of our current knowledge of marine communities and how their component populations are limited and interact with one another.

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.

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. Offered in alternate years.

ZOOL 708 Lectures in Zoology. (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 709 Lectures in Zoology. (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

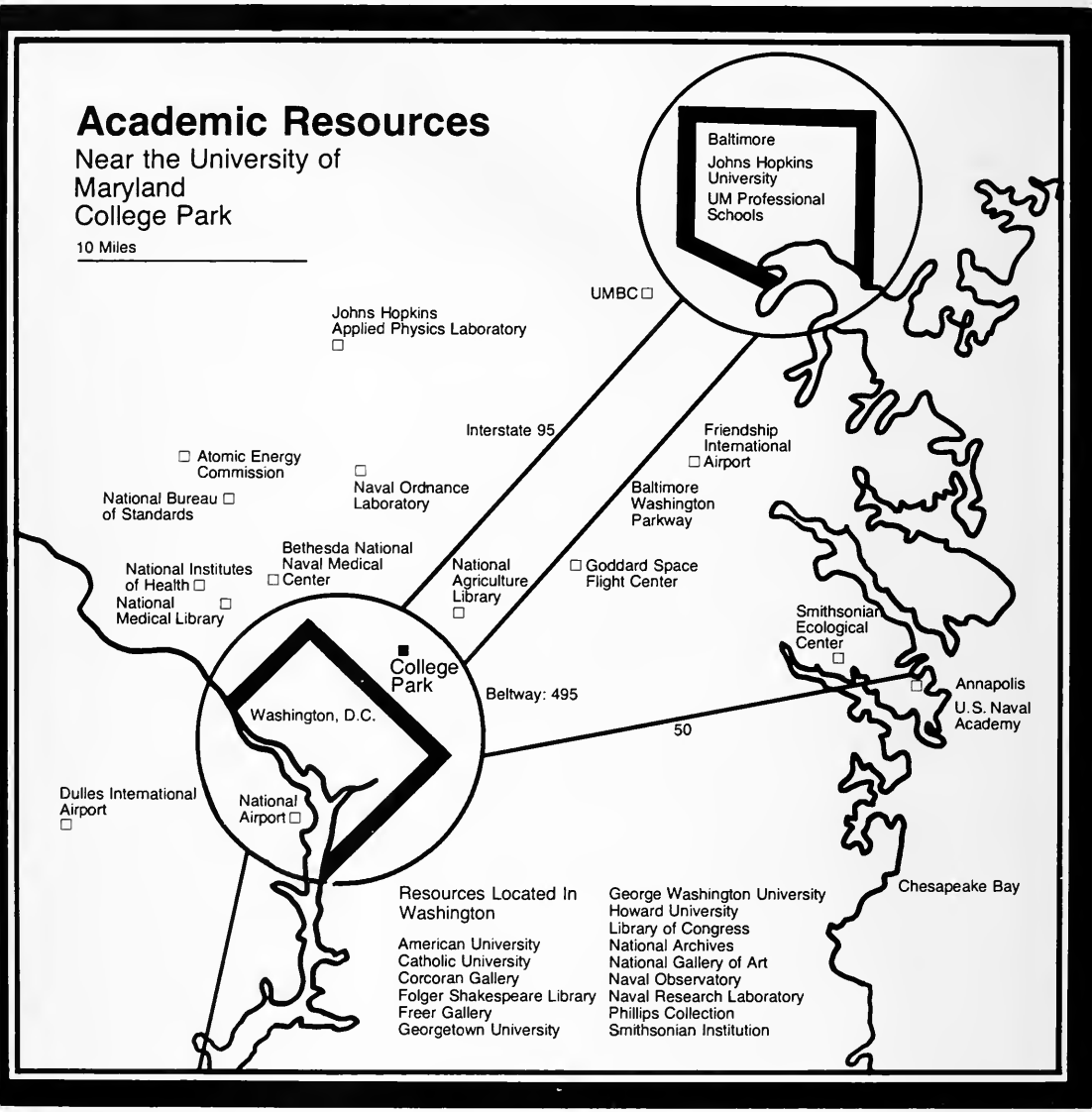
ZOOL 771 Helminthology. (4) Two lectures and two three-hour laboratory periods a week. Prerequisites, two years of zoology and permission of the instructor. A study of the classification, structure and biology of the helminths.

ZOOL 778 Advanced Topics in Protozoology. (3) 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 once since topic coverage will change. May be repeated to a maximum of twelve semester hours.

ZOOL 799 Master's Thesis Research. (1-6)

ZOOL 878 Advanced Topics in Parasitology. (1-16) 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)


Academic Resources
Near the University of Maryland College Park
10 Miles
Baltimore
Johns Hopkins University
UM Professional Schools
UMBC
Johns Hopkins Applied Physics Laboratory
Interstate 95
Friendship International Airport
Atomic Energy Commission
Naval Ordnance Laboratory
National Bureau of Standards
Baltimore Washington Parkway
Bethesda National Naval Medical Center
National Institutes of Health
National Medical Library
National Agriculture Library
Goddard Space Flight Center
Smithsonian Ecological Center
College Park
Beltway: 495
Annapolis
U.S. Naval Academy
Washington, D.C.
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Dulles International Airport
National Airport
Chesapeake Bay
Resources Located In Washington
American University
Catholic University
Corcoran Gallery
Folger Shakespeare Library
Freer Gallery
Georgetown University
George Washington University
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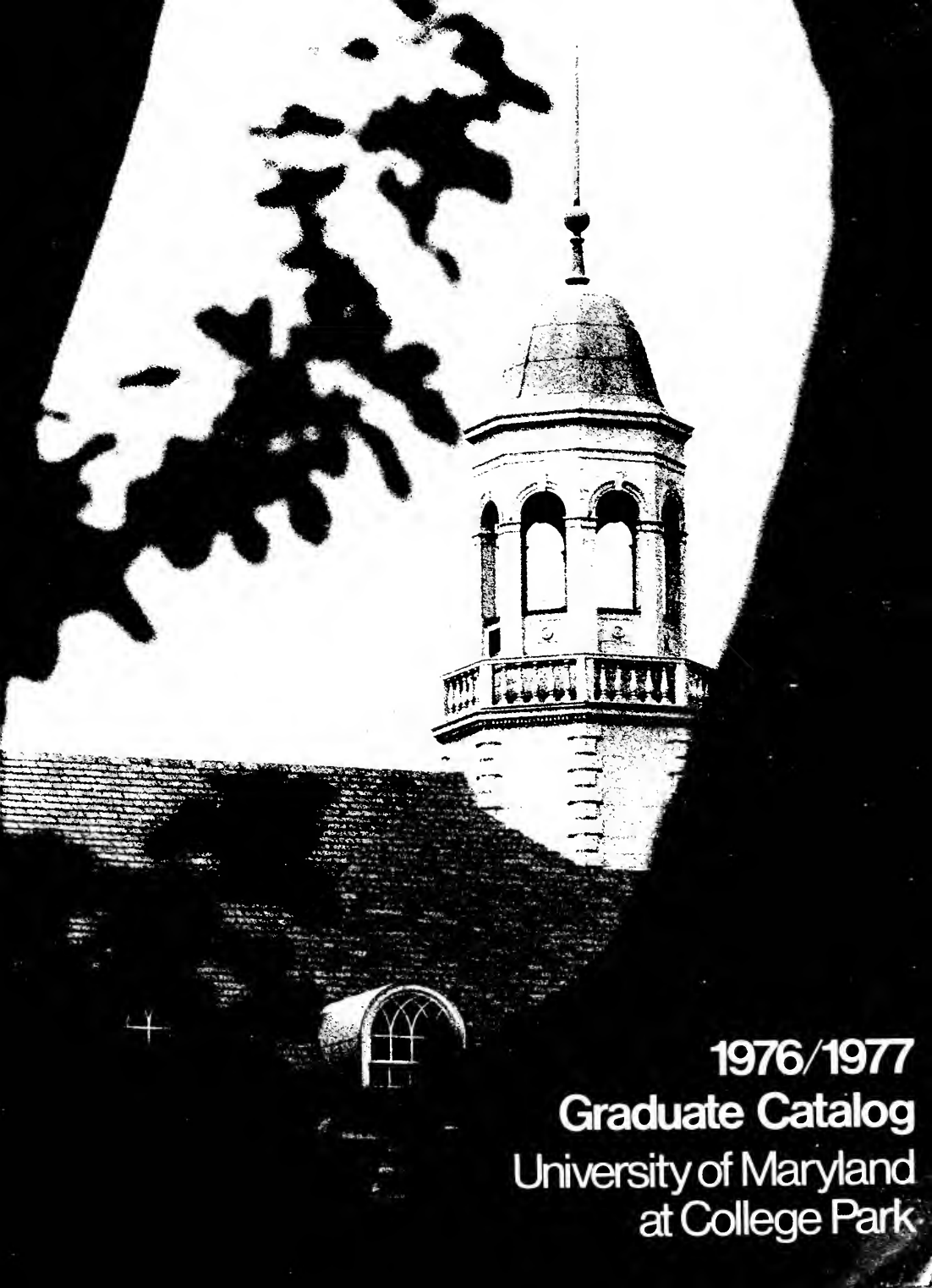

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