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GRADUATE SCHOOL

1970-1972

UNIVERSITY OF MARYLAND BULLETIN

The University of Maryland has been elected to membership in the Association of American Universities. This Association founded in 1900, is an organization of those universities in the United States and Canada generally considered to be preeminent in the fields of graduate and professional study and research.

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

COURSE CATALOG

GRADUATE SCHOOL

UNIVERSITY OF MARYLAND

1970-1972

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University Calendar 1970-1971

FALL SEMESTER, 1970

SEPTEMBER	8-11	Tuesday-Friday	Fall Semester Registration
	12	Saturday	Teacher Registration
	14	Monday	Instruction begins
NOVEMBER	25	Wednesday	After last class—Thanksgiving recess begins
	30	Monday	8:00 a.m.—Thanksgiving recess ends
DECEMBER	18	Friday	After last class—Christmas recess begins

1971

JANUARY	4	Monday	8:00 a.m.—Christmas recess ends
	13	Wednesday	Pre-exam Study Day
	14-19	Thursday-Tuesday	Fall Semester Examinations
	20	Wednesday	Study Day
	21-22	Thursday-Friday	Fall Semester Examinations

SPRING SEMESTER, 1971

FEBRUARY	1-5	Monday-Friday	Spring Semester Registration
	6	Saturday	Teacher Registration
	8	Monday	Instruction begins
APRIL	9	Friday	After last class—Spring recess beings
	19	Monday	8.00 a.m.—Spring recess ends
MAY	26	Wednesday	Pre-exam Study Day
	27-29	Thursday-Saturday	Spring Semester Examinations
	31	Monday	Memorial Day
JUNE	1-4	Tuesday-Friday	Spring Semester Examinations
	5	Saturday	Commencement

SUMMER SESSION 1971 (TENTATIVE)

JUNE	21-22	Monday-Tuesday	Registration
	23	Wednesday	Instruction Begins
AUGUST	6	Friday	End of Six Week Session
	20	Friday	End of Eight Week Session

FALL SEMESTER 1971 (TENTATIVE)

SEPTEMBER	7-10	Tuesday-Friday	Fall Semester Registration
	1	Saturday	Teacher Registration
	13	Monday	Instruction Begins
NOVEMBER	24	Wednesday	After last class—Thanksgiving recess begins
	29	Monday	Thanksgiving recess ends
DECEMBER	17	Friday	After last class—Christmas recess begins

1972

JANUARY	3	Monday	Christmas recess ends
	12	Wednesday	Pre-exam Study Day
	19	Wednesday	Pre-exam Study Day
	13-21	Thursday-Thursday	Fall Semester Examinations
	24	Monday	Fall Semester Commencement

SPRING SEMESTER 1972 (TENTATIVE)

JANUARY	31-4	Monday-Friday	Spring Semester Registration
FEBRUARY	5	Saturday	Teacher Registration
	7	Monday	Instruction Begins
MARCH	31	Friday	After last class—Spring recess begins
APRIL	10	Monday	8:00 a.m. Spring recess ends
MAY	24	Wednesday	Pre-exam Study Day
	25-JUNE 2	Thursday-Friday	Spring Semester Examinations
	31	Wednesday	Memorial Day
JUNE	3	Saturday	Commencement

MICHAEL J. PELCZAR, JR.
Vice President for
Graduate Studies and Research

The Graduate School

The Graduate School was established in its present form in 1918 under the jurisdiction of the Graduate Council with the Dean of The Graduate School, now the Vice President for Graduate Studies and Research, serving as chairman. It was created for the purpose of administering and developing programs of advanced study and research for graduate students in all branches of the University.

Despite the large expansion of graduate programs into new areas as the University has grown, the spirit of each program is essentially that of individual study under competent supervision. The Graduate School is not an extension of the undergraduate program, but was created rather for the preparation of those who, in the future, will carry on the spirit of individual inquiry.

Thus it promotes and provides an atmosphere of research and scholarship for both students and the faculty; in particular, it stimulates that harmonious relationship between the two which results in advancement of learning. At the present time over 70 graduate programs are authorized leading to one or more of the advanced degrees awarded by the University upon the recommendation of the Graduate Faculty.

The Graduate Faculty, working through the Assembly and the Graduate Council, establishes the policies governing admission to graduate study and the minimum requirements to be met by all students seeking each of the degrees it offers. The faculties of the individual academic departments or interdisciplinary programs frequently establish additional requirements for admission to graduate study or for individual degree programs above the minima established for The Graduate School as a whole.

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

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

In its work the Graduate Council is aided and advised by nine standing committees. Membership on these committees is limited to members of the Graduate Faculty and graduate students and the members are appointed by the Vice President for Graduate Studies and Research. Student members serve with both voice and vote. The standing committees are:

Committee on Academic Standards
Committee on Elections and Procedures
Committee on Fellowships
Committee on Graduate Faculty
Committee on Foreign Languages
Committee on New Programs and Courses
Committee on Research
Committee on Student Welfare
Committee on Publications

In addition a Committee on Five Year Reviews has recently been established to advise the Council on policies and procedures governing the periodic review of all degree programs.

The Vice President for Graduate Studies and Research serves as chairman and executive officer of both the Graduate Council and the Graduate Faculty Assembly.

General Information

Nondiscrimination

The University of Maryland, in all its branches and divisions, subscribes to a policy of equal educational opportunity for all without regard to race, creed, ethnic origin or sex.

Enrollment

Over 9,000 graduate students were enrolled during the Fall 1970 Semester. Over half of these were full-time students. The student body included students from virtually every state in the Union and 58 foreign nations. During the 1969-70 academic year, 350 doctorates and 1,417 master's degrees were awarded.

Location

The Office of the Vice President for Graduate Studies and Research, which includes The Graduate School offices, is located in the new Graduate School Building on the College Park campus. This campus is located in Prince Georges County on over 1,300 acres of land less than eight miles from the White House and the National Capitol building in Washington, D.C., and approximately 32 miles from Baltimore.

The Graduate School also maintains an office for the Associate Dean of the Graduate School for the Baltimore campuses at Baltimore (See Graduate Degree Programs, Baltimore Professional Schools).

The Baltimore campus of the University is located in the southwest section of the city and occupies a several block area centering on Lombard and Greene Streets. Graduate programs offered on this campus include those in the several departments of the Schools of Medicine, Dentistry, Pharmacy, Nursing, and Social Work. The University's School of Law is also located on the Baltimore campus.

The Baltimore County campus of the University of Maryland is located adjacent to the exit of the Baltimore Beltway at Catonsville. Limited opportunities for graduate study are presently available at this location and will be expanded in the years to come. The University of Maryland, Eastern Shore is located at Princess Anne. Opportunities for graduate study will be developed on this campus in the future.

These four campuses of the University are located in the midst of one of the greatest concentrations of research facilities and 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 the

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, with special collections for Chemistry, Engineering and the Physical Sciences, and the Health Sciences located near the classrooms and laboratories of these disciplines. The collections have passed the one million mark and are growing rapidly.

The library at the Baltimore County Campus is growing rapidly and already provides unusual opportunities for research in several disciplines. It is connected to the other University libraries by rapid communications and delivery services.

Study carrels, book lockers, and a wide variety of special services are available to advanced students engaged in research.

Special Research Resources

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

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

Work in the behavioral sciences, particularly in learning, is centered in laboratories equipped for fully automated research on rats, pigeons, and monkeys, on both the Baltimore and College Park campuses. A major shock trauma research facility, which operates on line with an IBM 360/44 computer, has been developed on the Baltimore campus.

Exceptional research facilities in the physical sciences include a 160 MeV cyclotron; two small Van de Graaff accelerators; an assortment of computers, including an IBM 7094, two 1401's, and a Univac 1108 which is complemented by remote access units on a time-sharing basis; a 10 KW training nuclear reactor; a full-scale low velocity wind tunnel; several small hypersonic helium wind tunnels; a 1,500 Curie cobalt 60 source; specialized facilities in both the Institute for Molecular Physics and the new Center for Materials Research; a psychopharmacology laboratory; shock tubes; a quiescent plasma device (Q machine) for plasma research; and rotating tanks for laboratory studies of meteorological phenomena. The University also owns and operates the world's longest radio telescope, located in Clark Lake, California.

Special collections of interest to scholars in the humanities include the newly acquired personal papers of Katherine Anne Porter, a rapidly growing collection of books and documents on early Maryland, a unique collection of newspapers and journals published in Japan during the American occupation, and

a very extensive collection of photographs of modern America given to the University by *Look Magazine*.

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, 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, which makes the University of Maryland one of the most attractive in the nation for students and scholars in the humanities and the social sciences.

Special Opportunities for Artists and Students

Advanced work in the creative and performing arts centers in the Tawes Fine Arts Building and is greatly stimulated by the close interaction that has developed between the students and faculty of the University and the artists and scholars at the National Gallery, the Corcoran Gallery, the Phillips Gallery, the Museum of Modern Art, the Smithsonian Institution, as well as the musicians of the National Symphony Orchestra and smaller musical groups. The completion of the Kennedy Center for the Performing Arts in 1971 will further enhance the climate for creative artists attending the University.

Outstanding work on campus in theater, dance, radio, and television is enhanced 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.

For the past three years the University of Maryland has hosted the National Conference on Poetry and the National Conscience, and the program in creative writing is winning wide recognition for both its scope and high quality.

Admission To Graduate School

General: Admission to graduate study at the University of Maryland is the exclusive responsibility of The Graduate School and the Vice President for Graduate Studies and Research. In making decisions upon the admissibility of applicants, the Vice President and his staff regularly seek the advice of the heads of the academic departments and graduate faculty admissions committees. In the case of foreign student applicants, the University's Director of International Education Services and Foreign Student Affairs is also consulted.

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

There are, however, minimum standards which apply to all applicants regardless of program or time. They have been established on the basis of long experience with those who have succeeded, as well as with those who have

failed, in graduate study. They are similar to those standards governing admission to nearly all major graduate schools. The purpose of these standards is, quite simply, to distinguish between those individuals who have a reasonable expectation of successfully completing a graduate program and those individuals who would be better advised to devote their time and energies to other endeavors.

Minimum Standards: The basic minimum standard for admission to The Graduate School is a "B" average, or 3.0 on a 4.0 scale, as an undergraduate student who has completed 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 must reflect successful completion of the prerequisites for graduate study in the chosen field. Normally the "A" grades that contribute to the required "B" average will have been earned in the subject, or a closely allied one, which the student wishes to pursue in The Graduate School. A very few students, who fail to meet these minimum standards, may be admitted to graduate study as provisional students on the basis of outstanding performance on one or more of the graduate study aptitude tests, or on the basis of letters of recommendation from competent judges of their performance as students or in a professional capacity. Standards for admission to a doctoral program are invariably higher than for admission to a master's program.

Evidence of Academic Potential: In the interests of providing those who review the qualifications of each applicant with the best possible information on which to base their recommendations, applicants may be required to submit, in addition to the required transcripts of all previous study, other data as follows:

The Graduate Record Examinations: Many of the graduate programs do not now require the Graduate Record Examination Test Scores as part of the application procedure, but most will use such test scores as an additional measurement of an applicant's qualifications. The Graduate Record Examination may be taken in either or both of two forms, 1) The Aptitude Test and, 2) The Advanced Test in material basic to graduate study in a major field. Both forms of the test are required as part of the application procedures by the programs in economics, geography, government and politics, history, microbiology, psychology, sociology, zoology and dentistry. The Advanced Test only is required by astronomy and physics. Programs in aerospace engineering, mechanical engineering, French and Italian, home economics, library and information services, philosophy, medicine and social work require only the Aptitude Test. Applicant can complete this test in their senior year or when filing an application for admission. Applicants should write to the Graduate Record Examinations, Educational Testing Service, Princeton, N.J. 08540 for details.

The Admission Test for Graduate Study in Business: Applicants for programs in business administration are required to take the Admission Test for Graduate Study in Business (ATGSB) and present the results as part of their application for admission. Since this test is given only at limited times and places during the year, applicants should make arrangements early to register for this test. Details about registration may be obtained by writing to the Educational Testing Service, P.O. Box 592, Princeton, N.J. 07110.

The Miller Analogies Test: A graduate level form of the Miller Analogies Test is required of applicants prior to admission for all programs in psychology

and at the doctoral level in all areas of education including agricultural extension education. The Miller Analogies Test is given twice each month. For details write to the Director, Counseling Center, University of Maryland, College Park, Md. 20742.

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

Letters of Recommendation: Letters of recommendation are required of all doctoral applicants only in the following programs: Agricultural and Extension Education, American Studies, Business Administration, Civil Engneering, Education, Geography, Music, Spanish and Portuguese, Biological Chemistry (School of Medicine), and Cell Biology and Pharmacology (School of Medicine). *All other programs* require letters of recommendation at both the doctoral and master's level from *all* applicants. Letters of recommendation should be sent directly to the program to which the applicant expects to be admitted.

Interviews: An applicant whose qualifications for graduate study do not meet the usual standards for admission or are in some respects unusual may be invited to the campus for a personal interview with a member of the graduate faculty or the admission committee of a particular program or department. In such cases the applicant will be notified by the member of the faculty or by the appropriate admissions committee.

Qualifying Programs: In a very few programs, notably those in the College of Education, there is a qualifying program open to students who fall slightly below the minimum standards for admission to provisional status in The Graduate School. Successful completion of a qualifying program normally provides the basis for recommendation for admission to The Graduate School. Students should apply directly to the Director of Graduate Studies, College of Education, for further information about the qualifying program.

Readmission, Change of Objective, Cancellation of Admitted Status: Students are admitted only for the purpose or objective stated on the application for admission. A new request for admission must be submitted when the original objective has been attained or if the student wishes to change his objective. The admitted status terminates when time limits have been exceeded or when other conditions required for continued admitted status have not been met.

The admitted status of all students, both degree and non-degree seekers, is continued at the discretion of the major professor, the department or program director, and The Graduate School. Students must maintain an average grade of B or better and must otherwise satisfy all additional departmental and Graduate School program requirements.

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. If approved, he may begin his advanced degree program immediately.

Provisional Graduate Status: This designation may be used when (1) the

previous academic record at a regionally approved 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 these 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 "full status." Students who are unable to qualify for full admission may be considered for another program or dismissal.

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 permitted to enroll on a "course work only" basis for a specified time if their work meets Graduate School standards. Included would be the individual who already has an advanced degree and who wants to pursue a partial program not leading to another degree in order to gain more background in his original area or in another area of specialization. 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 transfer student who is in good standing as a graduate student at another institution (See also Transfer Student Application) and the student who wishes to attend an approved National Science Foundation Institute but does not want to apply for regular admission (See also Applications for National Science Foundation Institutes.)

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

Special Student Status—Undergraduate

This is an undergraduate classification and it 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 accredited institution, but who do not desire or qualify for graduate admission.

Some graduate academic departments and degree programs have developed qualifying courses of study for special students. Those students who successfully complete one of these programs may be recommended for admission to The Graduate School. The student is warned, however, that no credit earned while a special student may be applied at a later date to a degree program.

Special students may enroll for courses at the 100 to 199 level (courses open to advanced undergraduate and graduate students) for which they possess the necessary prerequisites. They may not, however, enroll in courses restricted to graduate students only, those numbered 200 and above.

Application for Admission

How to Apply: Initial correspondence concerning application for admission to The Graduate School should be addressed to *The Graduate School, University of Maryland, College Park, Md. 20742*. An application fee of $10.00 must accompany the application for admission. This fee is *not refundable under any circumstances*, but if the applicant is accepted and enrolls for courses, the fee will serve as a matriculation fee. 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 sets of separate official transcripts from each college or university attended must be received at the Graduate School by July 15 for the Fall semester, by December 15 for the Spring semester, and by May 15 for the Summer session.* Applicants who require financial support and want to be among those first considered must submit their applications by March 1 for the fall semester and by August 1 for the spring semester. A foreign student applicant should apply *at least six months* prior to the semester of expected entrance.

Applicants for admission should specify to their institutions that the transcripts should be sent directly to The Graduate School and not to the Registrar's Office or the department in which they intend to pursue their graduate study. Applicants who have graduated from the University of Maryland must also request the Registrar of the University of Maryland to send two copies of their transcript to The Graduate School. All transcripts should be received at The Graduate School on or before the deadline specified above. The applicant is *solely responsible* for seeing that the above conditions are met by the deadline date for the filing of the application for the semester of expected entrance. No follow-up procedures are undertaken by The Graduate School in this respect.

Application in the Senior Year: Students, including University of Maryland 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 matriculation if a complete record of all previous work is not received within three months following the completion of such study and the award of the degree.

Transfer Student Applications: A graduate student matriculated in another graduate school, who wishes to enroll for a single summer session or a single semester in The Graduate School of the University of Maryland, and who intends thereafter to return to the graduate school in which he is matriculated, may be admitted in a Non-Degree Graduate Status as a transfer student.

He must have been officially admitted to another recognized graduate school and must be in good standing. Full transcripts of his credits need not be submitted, but he must apply for admission to the Maryland Graduate School and pay the application fee. In lieu of transcripts, he must have his graduate dean certify, in writing, to The Graduate School of the University of Maryland, that he is in good standing and that any credits earned will be accepted toward his graduate degree at his home institution.

Foreign Student Applications: A foreign student wishing to be considered for admission to The Graduate School of the University of Maryland must keep

in mind that his application and official academic credentials—beginning with secondary school records—should be received by the Graduate Admission Office at least six months prior to the semester for which he plans to begin his studies. Applications may be rejected prior to this deadline when foreign student quotas have been exceeded. The University of Maryland, as a State institution, limits the number of foreign students it accepts. The University's complement of foreign students is selected from the best qualified graduate applicants. Unless the applicant ranked high in his graduating class in his own country, and unless his grades ranged from very good to excellent, it is unlikely that he will be admitted to the University's Graduate School.

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

A statement regarding the applicant's financial status is required by the Office of International Education Services and Foreign Student Affairs. Approximately $300.00 a month, or $3,600.00 a year, is required for educational and living expenses of two academic semesters and a summer session. Many departments and programs have assistantships available for outstanding graduate students; however, some of them require at least a year of study in the United States before considering the appointment of a foreign graduate student to an assistantship. Arrangements for assistantships must be made directly with the department or program. A foreign student applicant must therefore be prepared, in most cases, to meet his financial obligations from his own resources or from those provided by a sponsor for the first year of study, and perhaps beyond.

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

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

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

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

Applications for National Science Foundation Institutes

During the summer sessions and during 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. Graduate admitted status is only rarely required for participation in these programs since the course offerings are usually drawn from the 100 numbered series. Where the course offered through the NSF Institute is numbered in the 200 or higher series, admission to The Graduate School is mandatory. Individuals classified as special students may also qualify for these institutes (See also special students).

Application for admission to an NSF Institute should be made directly to the director of the NSF Institute, who 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 or where admission to a regular program is desired.

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

Offer of Admission

A written offer of admission will be made to an applicant who meets all admission requirements. The offer will specify the time of entrance which will normally coincide with the requested starting time. Applicants are urged to notify The Graduate School of their acceptance well before the time of expected entrance. The offer of admission lapses if the applicant does not indicate his acceptance of the offer of admission by registering for courses at the authorized time of entrance. An individual whose offer of admission has lapsed must submit a new application and fee, if he wants to be reconsidered for admission.

The offer of admission may be used as a permit-to-register for courses. Permanent identification as a graduate student will be issued at the time of first registration.

Records Maintenance and Disposition

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

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

Summer School

The University conducts a summer session at College Park, with a comprehensive undergraduate and graduate program, as well as Institutes and Special Programs. A separate bulletin is published giving full information on the summer session. This bulletin is available upon application to the Director of the Summer School, University of Maryland, College Park, Md. 20742.

Graduate Study in Professional Schools at Baltimore

Graduate degree programs leading to the Master of Science and Doctor of Philosophy degrees are offered in the professional schools in Baltimore. Such programs are offered by the various departments in the Schools of Dentistry, Medicine and Pharmacy as well as in the Schools of Nursing and Social Work and Community Planning (See Graduate Degree Programs, Professional Schools, Baltimore). Students pursuing graduate work in the professional schools must register in The Graduate School and meet the same requirements and proceed in the same way as do other graduate students in the other departments of the University.

Graduate Study at the University of Maryland Baltimore County (UMBC)

A full graduate program leading to the Master of Science and the Doctor of Philosophy degrees in applied mathematics will be available with the beginning of the Fall 1970 Semester. Upper level undergraduate courses equivalent to 100 level courses at the College Park campus will be available for graduate credit to UMBC students who have been offered admission by The Graduate School. A limited number of such credits may be applied toward a graduate degree with the approval of the academic advisor.

University Consortia

The University is a member of several university consortia. Among these are: The Oak Ridge Associated Universities, Incorporated; The University Corporation for Atmospheric Research; The University Research Association; The Inter-University Communications Council; The Universities Space Research Association; The Chesapeake Center For Field Biology; The Universities Research Association. Information concerning graduate student participation in the programs of these consortia is available from The Graduate School.

Off-Campus Graduate Offerings

A limited number of graduate level courses are available at on and off-campus locations in the evenings. For information concerning these offerings, contact The Graduate School, or the Dean, University College, University of Maryland, College Park, Md. 20742.

Graduate Work by Seniors at the University of Maryland

A senior at the University of Maryland who has nearly completed the requirements for the undergraduate degree may, with the approval of his undergraduate dean, the head of the department concerned and The Graduate School, register in the undergraduate college for graduate courses,

which may later be counted for graduate credit toward an advanced degree at this University. The student must be within seven credit hours of completing his undergraduate work and the total of undergraduate and graduate courses must not exceed 15 credits for the semester. Excess credits in the senior year cannot be used for graduate credit unless proper pre-arrangement is made. Seniors who wish to register for graduate credit should inquire at The Graduate School about procedure.

Registration

Graduate Credit: Students admitted to The Graduate School must pay graduate tuition fees whether or not the credit will be used to satisfy program requirements. *Graduate credit will not be given unless the student has been admitted to The Graduate School.* The admission of a new student is validated when he registers for and completes at least one course during the semester for which entrance was authorized.

Schedule of Classes: A Schedule of Classes listing courses, hours, class locations, and registration procedures is made available shortly before the beginning of each semester. Copies may be requested through the Office of the Registrar, University of Maryland, College Park, Md. 20742.

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

Continuous Registration

Following Advancement to Candidacy for any advanced degree by the Graduate Council every graduate student must register each semester, exclusive of the summer sessions, until the degree is awarded. Candidates working toward the degree under a non-thesis option must also continue to enroll until certification has been made to the Graduate School by the faculty advisor that all requirements have been fulfilled. The fulfillment of this requirement can be accomplished in one of two ways:

1. Regular Registration:

a. Those students who have not fulfilled the minimum requirement of six semester hours of master's research (399 or 799), or twelve semester hours of doctoral research (499 or 899) (beginning with the 1971 summer session, code numbers for master's research will change to 799 and doctoral research to 899), must continue to register for at least one credit hour of the appropriate level of research. Likewise, students who may already have registered for the required minimum number of hours of research but who are still consulting with their faculty advisors, taking comprehensive examinations, using the libraries, laboratories, or other research or academic resources of the University, must continue to register for at least one credit hour of the appropriate level of research. Registration must be performed, in person, at the time periods and with the conditions specified for the normal registration for all students.

b. Students who are subject to continuous registration as outlined in the foregoing paragraph, but who are residing outside of the State of Maryland or the District of Columbia, and who need to be registered for one or more hours of thesis research (399 or 799) or dissertation research (499 or 899) may request that The Graduate School perform the actual registration for them. The request, along with the appropriate tuition and auxiliary fees, should

be received in The Graduate School before the end of the regular registration for that semester. Requests received after regular registration and prior to the end of the eighth week of classes may be processed but are assessed a $20.00 late fee. Requests will not be processed after the eighth week of classes. Students residing within the areas specified above must register in person.

2. Continuous Registration Fee:

The student who has been advanced to candidacy by the Graduate Council, who has completed the minimum registration required for his coursework and research, and who is making no demands upon the resources of the University, including library resources, but who has not completed and will not during the current semester complete all degree requirements (comprehensives, orals, clearances by the Graduate Program Committee and The Graduate School), must maintain his admitted status by the payment of a Continuous Registration fee of $10.00 per semester, exclusive of summer sessions, until the degree has been awarded. The payment of this fee must be submitted, either in person or by mail, directly to The Graduate School, before the end of the eighth week of classes. No other fees are assessed students in this category. No academic credit is awarded, but the payment of this fee is entered upon the student's record in The Graduate School.

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

Requirements for the Degrees of Master of Arts and Master of Science

THESIS OPTION

Course Requirements. A minimum of 24 semester hours, exclusive of thesis and registration for research, with a minimum average grade of "B" in courses approved for graduate credit, is required for the degrees of Master of Arts and Master of Science. The student is also required to register for six semester hours for research or thesis work (399). The total number of credit hours required for the degree is 30. If the student is inadequately prepared for the required graduate courses, either in the major or minor subjects, additional courses may be required to supplement the undergraduate work. Of the 24 hours required in graduate courses, not less than 12 and not more than 16 semester hours must be earned in the major subject. The remaining credits must be outside the major subject and must comprise a group of coherent courses intended to supplement and support the major work. 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 200 or above. No credit for the degree of Master of Arts or Master of Science may be obtained for correspondence courses or those taken by examination. The entire course of study must constitute a unified program approved by the student's major advisor and by The Graduate School. All requirements for the degree must be completed within the specified five-year time period.

Transfer of Credit: Credit not to exceed six semester hours for course work at other regionally accredited institutions may be applied toward the master's

degree only when such course work has been taken after the student has been admitted to the University of Maryland Graduate School. Before taking course work for transfer, the student must have the approval of his advisor, the head of the department in his major field and The Graduate School. Normally, approval may be given only for courses which are not offered by the University of Maryland during the period of the student's attendance. The request for transfer of credit shall be submitted to the Graduate Council for approval when the student applies for admission to candidacy. The candidate is subject to final examination by this institution in all work offered for the degree.

Advancement to Candidacy. Each prospective candidate for the master's degree is required to make application for admission to candidacy not later than the date listed in The Graduate School Calendar for the semester in which the degree is sought. He must have completed at least 12 semester hours in graduate work at the University of Maryland. An average grade of "B" in all major and minor subjects is the minimum requirement. Courses completed with a "D" or "F" in the major and minor must be repeated.

Minimum Residence. A residence of at least two semesters, or the equivalent, at this institution is required.

Final Examination. The final oral examination is conducted by a committee appointed by the Vice President for Graduate Studies and Research. The student's advisor acts as the chairman of the committee. The chairman and the candidate are notified of the members of the examining committee prior to the period set for the oral examination. The chairman of the committee selects the exact time and place for the examination and notifies the other members of the committee and the candidate. The examination is normally conducted at the end of the semester, but upon recommendation of the student's advisor an examining committee may be appointed by the Vice President for Graduate Studies and Research at any time when all other requirements for the degree have been completed. A report of the committee is sent to the Vice President as soon as possible after the examination. Such a report is the basis upon which recommendation is made to the faculty that the candidate be granted the degree sought. The period for the oral examination is usually about one hour, but the time should be long enough to insure an adequate examination.

The examining committee also approves the thesis, and it is the candidate's obligation to see that each member of the committee has at least three days in which to examine a copy of the thesis prior to the date of the examination. A student will not be admitted to final examination until all other requirements for the degree have been met. In addition to the oral examination, a comprehensive written examination may be required at the option of the major department or program committee.

NON-THESIS OPTION

The requirements for the Master of Arts and the Master of Science degrees without thesis vary slightly among departments and programs in which this option is available. Standards for admission to these programs 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.

While the details of the requirements vary from program to program, all involve a residence requirement of at least two semesters, or the equivalent,

at this institution; a minimum of 30 semester credit hours in courses approved for graduate credit with a minimum average grade of "B"; a minimum of 18 semester credit hours in courses numbered 200 or above (those restricted to graduate students only); the submission of one or more scholarly papers, and the successful passing of a comprehensive final examination.

A student following a non-thesis master's program will be expected to meet the deadlines for application for admission to candidacy, application for a diploma and submission of final examination reports established for all other degree programs.

Requirements for the Degree of Master of Education

The Master of Education degree is designed to increase competence for various positions in education. In those major areas where it is applicable, up to half of the course work may be taken in the teaching field. Course work, seminar papers, and other requirements such as comprehensive examinations are substituted for the thesis. For requirements for the degree see "Statement of Policies and Proceudres, Master's Degrees in Education," available from the Director of Graduate Studies in Education, College of Education.

Requirements for the Degree of Master of Business Administration

The Master of Business Administration program is designed primarily to prepare students for positions of responsibility in business and government. Emphasis is placed on the development of analytical ability and reasoned judgment in decision making. Instructional methods include case analysis, seminar discussion and decision simulation. Computer familiarization is provided.

A core of four courses embraces the areas of business decisions central to the firm's operation; relevant analytical methods, especially quantitative techniques; behavioral factors affecting the managerial task and the environment in which business functions, especially in its relationship with government.

Beyond the core, further advanced work may be taken in management and in statistics, and a concentration may be undertaken in a field of special interest: accounting, finance, marketing, personnel and industrial relations, and transportation.

Among the factors which are considered in admission of students for graduate work in business administration are an undergraduate record evidencing high scholastic attainment and performance on the required *Admission Test for Graduate Study in Business*. This test is offered four times a year through the Educational Testing Service, Princeton, N.J. The test is not designed to test specific knowledge in specialized academic subjects, and normal undergraduate training provides sufficient general knowledge to answer the test questions.

Individuals who are qualified are accepted not only from the area of undergraduate business administration but from other areas, such as engineering, the sciences, the arts, the humanities, and other fields. The graduate program is offered only during the day and is conducted on the campus.

Those students whose major undergraduate work has been in areas other than business are required to complete certain basic core requirements in

business and economics with a "B" average before being admitted to candidacy for the degree of Master of Business Administration. These core course requirements are listed below:

Principles of Economics	6 hours	Marketing	3 hours
Principles of Accounting	6 hours	Management and Organization Theory	3 hours
Business Law	3 hours	Business Finance	3 hours
Statistics	3 hours		

Course Requirements. Course requirements for the degree of Master of Business Administration are: a minimum of 30 semester hours must be completed in courses numbered 200 or above; a minimum average of "B" must be earned in these courses. If the student is inadequately prepared for the required graduate courses, additional courses may be required to supplement the undergraduate work. Of the 30 hours required in graduate courses, not less than six and not more than 12 must be taken in a major subject. Courses covering the remaining subjects must be taken outside the major and must comprise a coherent group, as approved by the student's advisor. No credit for the degree of Master of Business Administration may be obtained for correspondence courses or by examination. The entire course of study must constitute a unified program approved by the student's advisor and by the Vice President for Graduate Studies and Research. All requirements for the degree must be completed within the specified time period.

The other requirements for the degree are the same as for the degree of Master of Arts and Master of Science.

Requirements for the Degree of Master of Music

Five majors are offered in the Master of Music program to allow the student to pursue advanced work in the area for which his experience and interest have best prepared him.

1. A major in the history and literature of music leads to a study of musical styles and literatures and of the methods and materials of systematic musicology. Each candidate must demonstrate that he possesses a reading knowledge of one foreign language. A thesis is required in which mastery of musicological method must be shown.
2. A major in theory leads to advanced work in analysis and the use of musical materials. A thesis of an analytical nature will normally be required.
3. A major in composition leads to the development of creative ability. A thesis consisting of an original composition of major proportions will be required.
4. A major in performance leads to advanced work in the history, literature, and theory of music, and will combine seminars in the literature of a particular instrument with advanced instruction in that literature. In this approach the final project will consist of a seminar paper of an analytical nature and a graduate recital.
5. A major in conducting leads to advance work in the skills and materials of conducting, as well as courses in the history, and literature and theory of music. A final major conducting performance is required in addition to a seminar paper dealing with some aspect of the conducting major.

At least nine semester hours of the 30 required for the degree will normally be in a field of music outside the major area (music theory in the case of the history-literature concentration, for example), and will constitute the minor area. In exceptional cases, a student may take minor courses (no more than nine hours) in a field outside music. History, philosophy, music education, American or English literature, and foreign languages are among the recommended minor fields.

All other requirements are the same as for the degree of Master of Arts.

Requirements for the Degree of Master of Library Science

The School of Library and Information Services offers course work leading to the degree of Master of Library Science designed to prepare students for professional practice in library and information service in each of the specialties of the field from children's work to information retrieval. The program constitutes a 36-hour course of study, normally to be completed in two semesters followed by a summer session, or the equivalent of part-time study over a more extended period. There is no thesis or comprehensive examination required.

Additional details may be obtained by addressing a request to the School of Library and Information Services, University of Maryland, College Park, Md. 20742.

Requirements for the Degree of Master of Social Work

The School of Social Work and Community Planning offers a program leading to the degree of Master of Social Work with concentrations in clinical social work and in social strategy. Concurrent field instruction is provided through cooperative arrangements with affiliated social agencies throughout Maryland and in adjacent states.

Two academic years of full-time study are required for completion of the School's requirements. An extended program permits a number of students to complete the degree program in a three or four year period. A limited number of part-time students are permitted to enroll for designated courses.

A comprehensive examination is given late in the semester in which the student seeks to complete requirements for the degree.

Requirements for the Advanced Graduate Specialist Programs in Education or Agricultural Extension Education

The Advanced Graduate Specialist program is designed for those who wish to develop high professional competence in an area of specialization, but who do not seek the doctorate. Students who wish to pursue this program must be admitted to The Graduate School and must have the master's degree or its equivalent.

Currently there are two A.G.S. certificate programs available. These are: (1) In the College of Education through the Graduate Programs in Education, and (2) In the College of Agriculture through the Graduate Program in Agricultural and Extension Education.

Requirements for the Degree of Doctor of Philosophy

Foreign Language Requirement. The Graduate Council, at its meeting on October 14, 1970, adopted the following resolution which was submitted by the Council's Committee on Foreign Languages.

The Graduate School foreign language requirement for the Ph.D. is hereby rescinded. The current requirements of the various departments and programs remain in force. They are subject to revision in accordance with the following policy.

Initially every department or program will have the option or redefining its present foreign language requirement for the Ph.D. in order to retain, delete, or modify the present requirement.

The Ph.D. language requirement will be formulated by each department or program. These requirements will be submitted to The Graduate School for the purpose of review.

As stated in this new policy, the foreign language requirement (if any) for the Ph.D. degree is to be formulated by the department or program offering the degree.

Advancement to Candidacy. Candidates for the doctor's degree must be admitted to candidacy at least one academic year prior to the conferring of the degree. Applications for admission to candidacy for the doctorate are made in duplicate by the student and submitted to his major department for further action and transmission to The Graduate School. Application forms may be obtained at the office of The Graduate School.

Preliminary examinations or such other substantial tests as the departments may elect are frequently prerequisites for admission to candidacy.

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

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 correspondingly increased. All work at other institutions offered in partial fulfillment of the requirements for the Doctor of Philosophy degree is submitted to the Graduate Council for approval, upon recommendation of the department concerned, when the student applies for admission to candidacy for the degree.

The doctorate 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.

Major and Minor Subjects: There is no Graduate School requirement for 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. All candidates for the Doctor of Philosophy

degree must, however, register for a minimum of 12 semester hours of doctoral research (499) at the University of Maryland.

Dissertation. The ability to do independent research must be proved by a dissertation on a topic selected from the student's major subject.

Final Examination. The final oral examination is conducted by a Committee of the Graduate Faculty appointed by the Vice President for Graduate Studies and Research. 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. In order to permit all members of the Committee adequate time to prepare for the examination a period of five days must elapse between the appointment of the Committee and the date of the examination. The time and place of the examination are established by the major professor who serves as Chairman of the Committee.

One member of the Committee is designated by the Vice President for Graduate Studies and Research as the official representative of the Graduate Faculty. It is the responsibility of this individual to examine the student's record and certify that all requirements have been met and to report the results of the examination to the office of The Graduate School.

Each Committee will include at least one member of the Graduate Faculty whose area of specialization is outside that of the Department or Program in which the student is majoring.

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

All final oral examinations are open to all members of the Graduate Faculty and other interested persons. Only the members of the Committee may vote, however.

Requirements for the Degree of Doctor of Education

The Doctor of Education degree is offered for students who desire to develop high competence for various types of professional work in education.

The basic requirements for the degree, particularly those of residence, courses, a major and minor, and for a final oral examination, are similar to those for the Doctor of Philosophy. For the specific requirements of the Doctor of Education degree, see the "Statement of Policies and Procedures, Doctor's Degrees in Education," which may be obtained from the Director of Graduate Studies in Education, College of Education, University of Maryland, College Park, Md. 20742.

Requirements for the Degree of Doctor of Musical Arts

The Doctor of Musical Arts degree is offered for students who wish to undertake work on the highest level in either of two areas—composition or literature-performance—in order to develop excellence as composers, performers or teachers. A balance between scholarly (research) and professional (creative) work is a basic element of the program.

Composition. The applicant must hold bachelor's and master's degrees, or the equivalent, in composition, and must submit an adequate number of his original works as evidence of his musical maturity and creative ability. Placement and qualifying examinations, the presentation of a lecture recital and a program of his own compositions, and the successful completion of the doctoral foreign language requirement, are prerequisites for admission to candi-

dacy. The thesis will be a composition of major proportions, typically a symphony, concerto, ballet, or chamber opera.

Literature-Performance. The applicant must hold bachelor's and master's degrees, or the equivalent, in the area of specialization, and must perform an audition recital that includes representative repertoire from the various historical periods. Placement and qualifying examinations, the presentation of a lecture recital and two full-length recitals and the successful completion of the doctoral foreign language requirement are prerequisites for admission to candidacy.

Foreign Language Requirement. The department requires a reading knowledge of French, German or Italian and the passing of an examination covering the meaning of musical terms in French, German and Italian.

Other requirements are the same as those for the Doctor of Philosophy degree. Details of the program may be obtained from the Department of Music.

Requirements for the Degree of Doctor of Business Administration

The Doctor of Business Administration degree is designed for those planning to teach business administration subjects at the university level and for those preparing for research or management responsibilities in industry, government and universities.

Admission to the program is based upon: (1) excellence in both undergraduate and graduate work, (2) the Admission Test for Graduate Study in Business (see description under the Master of Business Administration degree), (3) reports of academic observers on the applicant's work, and (4) other evidences of promising scholarship.

Program Requirements. Candidates for the Doctor of Business Administration degree are required to develop competence in the following five concentrations:

1. Financial Administration
2. Human Behavior in Business
3. Quantitative Methods
4. Business Logistics
5. Management

Requirements under the five basic concentrations may be fulfilled through approved combinations of work in the following fields: accounting, finance, organization theory, personnel administration, mathematics, computer science, marketing, transportation, production management, and public policy.

Examinations. Candidates are required to complete written examinations in each of the five concentrations noted above. Following the written examinations, the candidate is examined orally by a committee of the Graduate Faculty. Candidates must apply and be advanced to candidacy for the Doctor of *awarded.*

Dissertation. A written dissertation, exhibiting competence in the analysis, interpretation and presentation of research findings is required of all candidates. Each candidate is required to register for 12 semester hours of dissertation research (499).

Upon being advanced to candidacy, the candidate must present to his appointed dissertation committee a *Dissertation Proposal,* which sets forth objectives of the research plan, its scope, methodologies to be employed, types and

sources of data to be sought, and time requirements for completion. When approved, the candidate completes the dissertation under direction of his committee. An examination on the dissertation is conducted by a committee of the Graduate Faculty appointed by the Vice President for Graduate Studies and Research.

Graduate Degree Programs

UNIVERSITY OF MARYLAND AT COLLEGE PARK

	Degrees Offered
Aerospace Engineering	M.S., Ph.D.
Agricultural Economics	M.S., Ph.D.
Agricultural and Extension Education	M.S., A.G.S., Ph.D.
Agricultural Engineering	M.S., Ph. D.
Agronomy	M.S., Ph.D
American Studies	M.A., Ph.D.
Animal Science	M.S., Ph.D.
Art	M.A., Ph.D.
Astronomy	M.S., Ph.D.
Botany	M.S., Ph.D.
Business Administration	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	M.S., Ph.D.
Dairy Science	M.S., Ph.D.
Economics	M.A., Ph.D.
Education	
Administration, Supervision and Curriculum	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Adult Education	M.Ed., M.A., A.G.S.
Counseling and Personnel Services	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Early Childhood—Elementary Education	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Industrial Education	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Human Development—Institute for Child Study	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Measurement and Statistics	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Secondary Education	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Social Foundations	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Special Education	M.Ed., M.A., A.G.S., Ed.D., Ph.D.
Electrical Engineering	M.S., Ph.D.
English Language and Literature	M.A., Ph.D.
Entomology	M.S., Ph.D.
Food Science	M.S., Ph.D.
French and Italian Language and Literature	M.A., Ph.D.
Geography	M.A., Ph.D.
Germanic and Slavic Language and Literature	M.A., Ph.D.
Government and Politics	M.A., Ph.D.
History	M.A., Ph.D.
Home Economics	
Food	M.S.
Nutrition	M.S.
Textiles and Clothing	M.S.
General Home Economics	M.S.
Horticulture	M.S., Ph.D.
School of Library and Information Services	M.L.S., Ph.D.

Mathematics	M.A., Ph.D.
Mechanical Engineering	M.S., Ph.D.
Meteorology	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Music	M.M., D.M.A., Ph.D.
Philosophy	M.A., Ph.D.
Physical Education, Recreation and Health	
Physical Education	M.Ed., M.A., Ph.D.
Recreation	M.Ed., M.A., Ph.D.
Health Education	M.Ed., M.A., Ph.D.
Physics and Astronomy	M.S., Ph.D.
Poultry Science	M.S., Ph.D.
Psychology	M.A., M.S., Ph.D.
Sociology and Anthropology	M.A., Ph.D.
Speech and Dramatic Art	M.A., Ph.D.
Spanish and Portuguese Language and Literature	M.A., Ph.D.
Zoology	M.S., Ph.D.

BALTIMORE PROFESSIONAL SCHOOLS—BALTIMORE, MD.

School of Dentistry	Degrees Offered
Anatomy	M.S., Ph.D.
Biochemistry	M.S., Ph.D.
Histology and Embryology	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Oral Pathology	M.S., Ph.D.
Physiology	M.S., Ph.D.
Oral Surgery	M.S.
School of Medicine	
Anatomy	M.S., Ph.D.
Biological Chemistry	M.S., Ph.D.
Biophysics	M.S., Ph.D.
Pathology, Medical	M.S., Ph.D.
Pathology, Legal Medicine (Toxicology)	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Cell Biology and Pharmacology	M.S., Ph.D.
Physiology	M.S., Ph.D.
School of Pharmacy	
Pharmaceutics (Pharmacy)	M.S., Ph.D.
Pharmacognosy	M.S., Ph.D.
Medicinal Chemistry	M.S., Ph.D.
Pharmacology and Toxicology	M.S., Ph.D.
Institutional Pharmacy	M.S.
School of Nursing	
Nursing	M.S.
School of Social Work, and Community Planning	
Social Work	M.S.W.

UNIVERSITY OF MARYLAND BALTIMORE COUNTY

Applied Mathematics	M.S., Ph.D.

Futher inquiries about specific degree programs should be directed to:

1. *For departments located at College Park:*

   Name of Department
   The University of Maryland
   College Park, Md. 20742

2. *For departments located in Baltimore:*

   Name of Department—School of (name)
   The University of Maryland
   Baltimore, Md. 21201

3. *For departments located at UMBC:*

   Name of Department
   University of Maryland Baltimore County
   5401 Wilkens Avenue
   Baltimore, Md. 21228

ADDITIONAL INFORMATION

Definition of Residence and Non-Residence Status

A person shall be eligible to register with the "University of Maryland residence status" only if he has been domiciled in the State of Maryland for *six consecutive months* preceding the last day on which registrations are acceptable for a given term.

This regulation is interpreted as follows:

The residence status of a minor follows that of the parents or guardian. Minors under guardianship are required to present proof of same and of actual residence in Maryland at the time of and prior to being legally declared under guardianship as may be requested. If the parent of a Maryland resident student (minor) permanently leaves the State for a period of six months, the minor student loses his Maryland residence status.

No person shall gain or lose his University residence status solely because of living in Maryland as a student. Adult students (21 years of age or older) are considered to be residents if, at the time of their first registration, they have been domiciled in Maryland for at least six months and, provided further, that such residence has not been acquired while attending any school or college in Maryland or elsewhere.

In the case of members of the armed services stationed in Maryland, the length of time stationed in Maryland is not considered in establishing residence at the University of Maryland if the individual entered the service as a *bona fide* resident of another state. The fact that members of the armed services may become registered voters in Maryland and pay income taxes while stationed in Maryland is not considered a basis for assignment of Maryland residence status at the University.

The burden of enrolling as a student in the University in the proper residence status is the responsibility of the student. Misrepresentations of fact in order to evade payment of non-resident tuition shall be considered sufficient cause for suspension or permanent exclusion from the University.

Infirmary Services

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

Both full-time and part-time graduate students enrolled in programs on the Baltimore City campus have available the facilities and services of the Student Health Service Center.

Living Accommodations

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

An active file of off-campus rooms and houses is available on a self-service basis to all persons. It is located in the Off-Campus Housing Office, Room 306, North Administration Building, University of Maryland, College Park, Maryland 20742. Single rooms rent for as low as $40-$50 per month while double rooms rent for $30-$40. There are many apartment complexes at varying rentals in the area. It would be advisable to arrive at the University as far in advance of registration as possible to choose from among the more desirable locations. The "Guide To Graduate Life" lists housing hints for College Park.

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

Housing on a limited basis is available for graduate students on the Baltimore City Campus at the Student Union Building. The dormitory-style rooms rent for $200.00. For further information, write to the Director, Student Union, University of Maryland, Baltimore, Maryland 21201.

At UMBC, the Office of Student Life maintains off-campus housing lists which graduate students may consult.

Married Student Housing

The University maintains approximately 475 garden-type apartments at locations within walking distance of the campus at College Park. Although intended primarily as housing for full-time married graduate students, approximately 50 efficiency apartments are available for assignment to full-time graduate students who are not married. Priority is given to teaching assistants. All apartments are equipped with an electric refrigerator and a gas range, but otherwise are *unfurnished*. Monthly rental rates are $82.00-$87.00 for efficiencies, $92-00-$102.00 for one bedroom units and $110.00-$115.00 for two bedroom units.

To be eligible for this housing, applicants and assigned residents must enroll in a sufficient number of hours to assure normal progress in a degree pro-

gram, as determined by the University. All applicants must be officially admitted to the University before an application can be considered. Applications for these units are available upon request by contacting University of Maryland Apartments, Rental Office, 3424 Tulane Drive, Hyattsville, Md. 20783, telephone (301) 422-7445.

Financial Aid

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

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

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

Summer Dissertation Fellowships are available to those graduate students who have completed all other requirements for the doctoral degree and expect to complete their dissertation by August 31. A stipend of $660 is provided to enable the student to devote full time to the completion of the dissertation during July and August.

Fellowships or traineeships are also available under the National Defense Education Act, the National Science Foundation, and the National Institutes of Health, as well as from several foundations and private industry.

All applicants for fellowships must be admitted to The Graduate School on a full-time basis to be eligible.

Assistantships. Teaching and research assistantships are available to qualified graduate students. These carry stipends of $2,800 or $3,600 per year for a 10 or 12-month appointment. The stipend for Teaching Assistants is $3,000 for the second year (or beyond) and $3,200 for Teaching Assistants admitted to candidacy for the doctorate. Applications for assistantships should be made directly to the department in which the applicant will study.

A substantial number of Resident Graduate Assistantships in the undergraduate residence halls are available. The stipend is $2,800 per year, plus remission of tuition fees in exchange for half-time work as Residence Halls Staff members. These Resident Assistantships are open to both men and women. Applications for a Residence Graduate Assistantship should be made to the Director of Housing, University of Maryland, College Park, Md. 20742.

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

Student Loans. National Defense Education Act Loan Funds are available to graduate students of the University of Maryland. The student may request up to $2,500 per year. However, because of limited funds, loans of more than

$1,200 per year are rarely made. Applications should be directed to the Director, Office of Student Aid, North Administration Building, University of Maryland, College Park, Md. 20742.

Commencement

Application for the diploma must be filed with the Office of the Registrar 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 in the Office of the Registrar during the first week of classes.

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

Grades

The following symbols are used for grades: "A", "B", "C", and "S"—Passing, "D" and "F"—Failure, and "I"—Incomplete. Since graduate students must maintain an overall "B" average, every credit hour of "C" in course work must be balanced by a credit hour of "A". A grade of "A" in thesis research will not balance a grade of "C" in a course. *All incomplete grades must be removed before the end of the semester and before the degree is conferred.* Incompletes received for master's thesis or doctoral dissertation credits will be removed when the applicable research has been certified by the appropriate Graduate Research Committee.

Course Numbering System

Advanced Undergraduates and Graduates 100-199

Graduate level courses which may also be taken by students not admitted to The Graduate School; however, credit cannot be applied toward a graduate degree program.

Graduate Students Only 200-upwards

Registration for these courses permitted only for those students who have been admitted to The Graduate School.

Research

Master's Level	399
Doctor's Level	499

A new course numbering system will be placed into effect with the 1971 Summer Session. The 1971 Summer School Catalog and the Schedule of Classes for Fall of 1971 will include both old and new numbers.

Courses will be designated as follows:

000-099	Non-credit courses.
100-199	Primarily freshmen 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 thesis 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 to be courses that are repeatable for credit. All non-repeatable courses must end in 0 through 7.

Graduate Fees

Application Fee

This fee is not refundable under any circumstances. If the student is accepted, this fee also satisfies the matriculation fee requirement. $10.00

Tuition Per Credit Hour:

Resident Student	$38.00
Non-Resident Student	$48.00
Maryland Teacher	$34.00

A Maryland teacher is defined for fee assessment purposes as any full-time professional employee of a school or college located in the State of Maryland and accredited by the State Department of Education. The teacher must be currently under contract or on official leave for the purpose of taking full-time graduate work at the University of Maryland. Teachers enrolling in the summer session will be considered as being currently under contract provided that they have a valid contract for the academic year immediately following the summer session.

Contract status must be established anew at each registration by the submission of a letter, or other appropriate document, provided by the Board of Education of the city or county or principal officer of the school or college in which the teacher is employed. If the letter or document is needed by the teacher for other purposes, he must supply a photocopy which will be retained by the registration clerk. The necessary letter, document or photocopy must be provided at the time of registration.

Auxiliary Facilities Fee $ 4.00

The Auxiliary Facilities Fee is paid into a fund which is used for expansion and operation of various facilities such as roads, walks, campus lighting and recreational facilities. These facilities are not funded or are funded only in part by State appropriations.

Continuous Registration Fee (per semester) $10.00

This fee is applicable to students who have been advanced to candidacy and who have completed required credit hours, but who have not completed the thesis or dissertation. This fee is to be paid by mail or in person directly to the Graduate School (see also Continuous Registration).

Recreation Fee (Summer School Only)	$ 3.00
Vehicle Registration Fee (College Park Only)	$10.00
Foreign Language Examination Fee (per language)	$10.00

Graduation Fee for Master's Degree	$10.00
Graduation Fee for Master of Social Work Degree	$15.00
Graduation Fee for Doctor's Degree	$50.00

Includes a hood, microfilming and binding of thesis, and publication in the *Dissertation Abstract*.

The bulletin, *An Adventure in Learning* contains a detailed statement of fees and expenses and includes changes in the fees as they occur. A copy may be obtained from the Admissions Office, North Administration Building, University of Maryland, College Park, Md. 20742.

Programs and Courses

AEROSPACE ENGINEERING

Professors: Corning, Pai, Rivello, Sherwood, and Thomas.
Associate Professor: Melnik.
Assistant Professors: Barlow, Donaldson, Jones, Plotkin, Shaeffer, and Weisshaur.
Lecturers: Anderson, Billig, Brandt, Fleig, and Wilson.
Instructor: Greenwood.
Visiting Assistant Professors: Filotas, and Sheinkar.

The Department of Aerospace Engineering offers courses and opportunities for research leading to the degrees of Master of Science and Doctor of Philosophy in aerospace engineering.

Facilities for graduate research include two subsonic and two supersonic wind tunnels, a hypersonic helium wind tunnel, a shock tube, a ballistic range, and complete structural loading and measuring equipment for both static and dynamic conditions. The University's computer facilities are available, as are other specialized research gear at nearby government laboratories.

For Graduates and Advanced Undergraduates

ENAE 101. Aerodynamics I. (3)
First and second semesters. Three lectures a week. Prerequisites, PHYS 021 and MATH 021. Basic fluid mechanics and aerodynamic theory. (Jones)

ENAE 102. Aerodynamics II. (3)
Second semester. Three lectures a week. Prerequisite, ENAE 101. Elements of compressible flow and application to engineering problems. (Melnik)

ENAE 107, 108. Design of Aerospace Vehicles. (4, 4)
First and second semester, two lectures and two lecture calculation periods a week. Prerequisites, ENAE 101, 102 and 113. (Corning)

ENAE 109,110. Flight Propulsion. (3, 3)
First semester, 3 lectures; second semester two lectures and one laboratory period a week. Prerequisites. ENME 001 and ENAE 101. Operating principles of air breathing and rocket engines. Thermodynamic processes and engine performance, aero-thermochemistry of combustion, fuels and propellants, energy for space flight. (Greenwood)

ENAE 111, 112. Elective Research. (2, 2)
One lecture and one laboratory period a week. Prerequisites, ENAE 102 and 113. Wind tunnel tests; structural tests. Written and oral reports on original research projects. (Staff)

ENAE 113, 114. Flight Structures. (4, 3)
First semester, three lectures a week; second semester, three lectures and one calculation period a week. Prerequisites, ENES 020 and MATH 066. Principles and problems of stress analysis and structural design of flight vehicles structures. (Rivello)

ENAE 115. Aerodynamics III. (3)
Prerequisite, ENAE 102. Elementary theory of the flow of an incompressible fluid. (Sherwood)

ENAE 117. Aircraft Vibrations. (3)
Three lectures a week. Prerequisite, MATH 066. Vibration and other dynamic problems occurring in structures. Specific topics of study include the free and forced vibration of single degree of freedom systems, damping, multiple degrees of freedom, beams and bars. (Donaldson)

ENAE 118. Dynamics of Aerospace Vehicles. (3)
Second semester. Prerequisites, ENAE 101, 102, 115. Stability, control, loads and miscellaneous topics in dynamics. (Barlow)

ENAE 180. Aerodynamics of High-Speed Flight. (3)
Prerequisites, ENAE 102 and 115, or equivalent. An advanced course dealing with aerodynamic problems of flight at supersonic and hypersonic velocities. Topics will include unified hypersonic supersonic small disturbance theory, real gas effects, aerodynamic heating and mass transfer with applications to hypersonic flight and re-entry. (Melnik)

ENAE 184. Flight Structures III.
Prerequisite, ENAE 114. 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 columns, buckling and failure of plates. (Rivello)

ENAE 190. Topics in Aeospace Engineering. (1-4)
Prerequisite, permission of instructor. May be taken for repeated credit up to a total of 6 credits, with permission of the student's advisor and the instructor. Selected topics from the literature of aerospace engineering. (Staff)

For Graduates

A. BASIC AERODYNAMICS

ENAE 220, 221. Aerodynamics of Incompressible Fluids. (3, 3)
Prerequisites, ENAE 101. ENAE 102. MATH 066. Fundamental equations in fluid mechanics. Irrotational motion. Circulation theory of lift. Thin airfoil theory. Lifting line theory. Wind tunnel corrections. Propeller theories. Linearied equations in compressible flow. Perturbation methods. (Plotkin)

ENAE 224, 225. Aerodynamics of Compressible Fluids. (3, 3)
Prerequisite, ENAE 115. 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 viscous compressible flow. Laminar boundary layer of compressible fluids. (Anderson)

ENAE 280, 281. Dynamics of Viscous Fluids. (3, 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. (This course is equivalent to ENME 280-281). (Jones)

B. APPLIED AERODYNAMICS

ENAE 230, 231. The Aerodynamics of High Altitude Vehicles. (3, 3)
Prerequisite, permission of instructor. Aerothermodynamic study of several types of high altitude, hypersonic vehicles, including ballistic, boost-glide and satellite vehicles. Examination of problems in stability, control, boundary-layer growth, shockwave interactions and convective and radiative heating. (Wilson)

ENAE 234, 235. Aerospace Facilities and Techniques. (3, 3)
Prerequisite, permission of instructor. Problems in supersonic and hypersonic tunnel development such as the aerodynamic design of nozzles, diffusers, storage systems and arc heaters. Shock tubes and shock tube wind tunnels. Development of ballistic ranges and basic considerations in the design of high-speed launchers. Instrumentation and data reduction. (Staff)

ENAE 236, 237. Heat Transfer Problems Associated with High Velocity Flight. (3, 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. (Wilson)

C. STRUCTURES

ENAE 250, 251. Advanced Flight Structures. (3, 3)
Prerequisites, MATH 066 and ENAE 113, 114, 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. (Rivello)

D. PROPULSION

ENAE 260, 261. Advance Propulsion. (3, 3)
Prerequisites, ENAE 109, 110. Special problems of thermodynamics and dynamics of aircraft power plants; jet, rocket and ramjet engines: plasma. ion and nuclear propulsion for space vehicles. (Billig)

E. DYNAMICS

ENAE 270, 271. Structural Dynamics and Aeroelasticity. (3, 3)
Prerequisites, MATH 066 and ENAE 114. 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. (Donaldson)

ENAE 274, 275. Advanced Structural Dynamics I, II.
Prerequisite, ENAE 270, 271 or equivalent. 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. (Donaldson)

F. GENERAL

ENAE 290. Seminar.
(Credit in accordance with work outlined by Aerospace Engineering staff). First and second semesters.

ENAE 291, 292. Selected Topics in Aerospace Engineering. (3, 3)
Prerequisite, permission of instructor. Topics of current interest and recent advances in the field.

ENAE 399. Thesis Research. (Master's Level)
(Credit in accordance with work outlined by Aerospace Engineering staff). First and second semesters. Prerequisite, graduate standing. (Staff)

ENAE 499. Dissertation Research. (Doctoral Level)
(Staff)

AGRICULTURE

Advanced degrees are not offered in general agriculture. However, the following courses may be taken by graduate students in departments offering graduate degrees with the permission of their graduate adviser.

For Graduates and Advanced Undergraduates

AGRI 101. Agricultural Biometrics. (3)
First semester. Two lectures and one laboratory period per week. Prerequisite, MATH 018 or equivalent. Probability, measures of central tendency and dispersion, frequency distributions, tests of statistical hypotheses, regression, analyses, multiway analysis of variance, and principles of experimental design with emphasis on the use of statistical methods in agricultural research.

AGRI. 197. Special Topics in Agriculture. (1-3)
First or second semester. 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.

For Graduates

AGRI 201. Advanced Agricultural Biometrics. (3)
Second semester. Two lectures and one laboratory period per week. Prerequisite, AGRI 101 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 205. Design of Experiments. (3)
First semester. Two lectures and one laboratory period per week. Prerequisite, AGRI 201 or its equivalent. The application of the principles of experimental design including basic and advanced designs, confounding, fractional replication and relative efficiencies.

AGRI 206. Statistical Methods in Biological Assay. (3)
Spring semester. Prerequisite AGRI 201 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 207. Application of Least Square Methods. (3)
First semester. Three lectures per week. Prerequisite, AGRI 201 or its 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 analyses of variants, analysis of covariants, and variants component analysis will be considered. Emphasis given to the use of least squares procedures for the analysis of data with unequal subclass numbers.

AGRI 210. 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. (Haut & Scott)

AGRICULTURAL ECONOMICS

Professors: Beal, Curtis, Evans *(Visiting Professor),* Foster, Ishee, Moore, Murray, Poffenberger, Smith, Stevens, Tuthill, Walker, Waugh *(Visiting),* and Wysong.
Associate Professors: Bell *(Visiting),* Bender, Cain, Hardie, Lessley, and Via.
Assistant Professors: Beiter, Hoecker, Holmes, Lawrence, Marasco, Nash *(Visiting),* Noetzel *(Visiting),* and Sokoloski *(Visiting).*

For Graduates and Advanced Undergraduates

AGEC 103. Introduction To Agricultural Business. (3)
First semester, alternate years. Offered 1970-71. (Lessley)

AGEC 106. Prices of Agricultural Products. (3)
Second semester. (Marasco)

AGEC 107. Financial Analysis of the Farm Business. (3)
First semester. (Wysong)

AGEC 108. Farm Management. (3)
Second semester. The organization and operation of the farm business in an economic framework. (Lessley)

AGEC 109. Introduction to Econometrics in Agriculture. (3)
First semester. (Ishee)

AGEC 111. Economics of Resource Development. (3)
First semester. (Tuthill)

AGEC 112. Agricultural Policy and Programs. (3)
First semester. (Beal)

AGEC 114. World Agricultural Production and Trade. (3)
First semester, alternate years. Offered 1971-72. (Foster)

AGEC 117. Agricultural Commodity Markets: An Economic Analysis. (3)
First semester, alternate years. Offered 1970-71. (Via)

AGEC 118. Marketing Management of Agri-Business Enterprises. (3)
Second semester, alternate years. Offered 1968-69. (Cain)

AGEC 119. Foreign Agricultural Economics. (3)
Second semester. (Holmes)

AGEC 185. Applications of Mathematical Programming in Business and Economic Analysis. (3)
First semester. (Bender)

For Graduates

AGEC 200. Application of Econometrics in Agriculture. (3)
First semester. Tools for analyzing demand and price behavior of agricultural products. Theories of least squares, estimation of structural economic relations in simultaneous equation systems, identification problems, and non-linear estimation techniques. (Bender)

AGEC 201. Advanced Theory and Practice of International Agricultural Trade. (3)
Second semester. Advanced theory, policies and practice in international trade in agricultural products. (Moore)

AGEC 202. Market Structure in Agriculture. (3)
Second semester. This course centers on the concept of market structure analysis, with application of principles developed to agricultural industries. (Moore)

AGEC 204. Advanced Agri-Business Management. (3)
Second semester, alternate years. Offered 1970-71. (Cain)

AGEC 208. Agricultural Price and Income Policy. (3)
Second semester. The evolution of agricultural policy in the United States, emphasizing the origin and development of governmental programs, and their effects upon agricultural production, prices and income. (Beal)

AGEC 210. Advanced Agricultural Price and Demand Analysis. (3)
First 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. (Marasco)

AGEC 212. Agriculture in World Economic Development. (3)
First semester. Theories and concepts of what makes economic development happen. Approaches and programs for stimulating the transformation from a primitive agricultural economy to an economy of rapidly developing commercial agriculture and industry. Analysis of selected agricultural development programs in Asia, Africa and Latin America. (Foster)

AGEC 214. Advanced Agricultural Marketing. (3)
Second semester. Advanced study of the complex theoretical, institutional and legal factors governing both domestic and foreign agricultural trade, with particular attention given to policies and practices affecting cost and price. (Cain)

AGEC 216. 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-output analysis. (Hardie)

AGEC 218. Agricultural Economics Research Techniques. (3)
First semester. Emphasis is given to philosophy and basic objectives of research in the field of agricultural economics. The course is designed to help students define a research problem and work out logical procedures for executing research in the social sciences. Attention is given to the techniques and tools available to agricultural economists. Research documents in the field will be appraised from the standpoint of procedures and evaluation of the search. (Staff)

AGEC 219. Advanced Resource Economics. (3)
Second semester. 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 132 or equivalent is a prerequisite. (Holmes, Tuthill)

AGEC 220. International Impacts of Selected Agricultural Forces. (3)
Second semester. Selected agricultural forces (such as pressure of population on food supply) and their impacts on the political, social, and economic development of the world. (Foster)

AGEC 300. Special Topics in Agricultural Economics. (3)
First and second semester. This course is designed to offer students special subject matter in the field of Agricultural Economics. Subject matter taught in this course will be varied and will depend on the persons available for teaching unique and specialized phases of Agricultural Economics. The course will be taught by the staff or visiting Agricultural Economists who may be secured on lectureship or visiting professor basis. (Staff)

AGEC 301. Special Problems in Agricultural Economics. (1-2) (4 cr. max.)
First and second semesters and summer. Intensive study and analysis of specific problems in the field of agricultural economics, which will provide information in depth in areas of special interest to the student. (Staff)

AGEC 302. Seminar. (1, 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. (Curtis)

AGEC 399. Thesis Research. (Master's Level)
First, second semesters and summer. Advanced research in agricultural economics. Credit according to work accomplished. (Staff)

AGEC 499. Dissertation Research. (Doctoral Level)
(Staff)

AGRICULTURAL ENGINEERING

Professors: Green, Harris, and Winn.
Associate Professor: Felton.
Assistant Professors: Hummel and Merkel.
Research Associate: Wheaton.

The Department of Agricultural Engineering 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 areas of agricultural power and

machinery, soil and water conservation engineering, agricultural structures, electric power and processing or aquacultural engineering.

For Graduates and Advanced Undergraduates

AGEN 113. Mechanics of Food Processing. (4)
Second semester. Three lectures and one laboratory a week. Laboratory optional. Prerequisite, PHY 001 or 010. (Merkel)

AGEN 121. Engineering Dynamics of Biological Materials. (3)
Second semester. Three lectures per week. Prerequisite, ENME 102. (Staff)

AGEN 123. Agricultural Production Equipment. (3)
First semester. Two lectures and one laboratory per week. Prerequisite, AGEN 001. (Hummel)

AGEN 124. Agricultural Materials Handling and Environmental Control. (3)
Second semester. Two lectures and one laboratory per week. Prerequisite, AGEN 001. (Staff)

AGEN 142. Functional and Environmental Design of Agricultural Structures. (3)
Second semester. Two lectures and one laboratory per week. Prerequisite, ENME 102. (Merkel)

AGEN 143. Functional Design of Machinery and Equipment. (3)
First semester. Two lectures and one laboratory per week. Prerequisite, ENES 021. (Hummel)

AGEN 144. Power Systems. (3)
First semester. Two lectures and one laboratory per week. Prerequisites, ENME 060, ENEE 060, and ENME 102. (Harris)

AGEN 145. Soil and Water Conservation Engineering. (3)
Second semester. Prerequisites, ENCE 090, and ENME 102. (Staff)

AGEN 165. General Hydrology. (3)
Second semester. (Staff)

AGEN 175. Engineering Hydrology. (3)
First semester. Prerequisites, MATH 066, ENCE 105 or ENME 102 (Staff)

AGEN 185. Aquacultural Engineering. (3)
Second semester. (Wheaton)

AGEN 198. Special Problems in Farm Mechanics. (1-3)
First and second semesters. Prerequisite, approval of Department. Problems assigned in proportion to credit. (Staff)

For Graduates

AGEN 201. Instrumentation Systems. (3)
First semester. (Winn)

AGEN 202. Biological Process Engineering. (3)
Second semester. (Staff)

AGEN 203. Mechanical Properties of Biological Materials. (3)
Second semester. (Harris)

AGEN 204. Land and Water Resource Development Engineering. (3)
First semester. (Green)

AGEN 301. Special Problems in Agricultural and Aquacultural Engineering. (1-6)
First and second semester and summer school. Work assigned in proportion to amount of credit. (Staff)

AGEN 302. Seminar. (1)
First and second semesters. (Harris)

AGEN 399. Thesis Research. (Master's Level)
(Staff)

AGEN 499. Dissertation Research. (Doctoral Level)
(Staff)

AGRICULTURAL AND EXTENSION EDUCATION

Professor: Ryden.
Associate Professors: Longest, and Nelson.

Programs are offered leading to Master of Science and Doctor of Philosophy in two majors: (a) agricultural education, with options in the Ph.D. program in teacher education, research and administration and supervision; and (b) extension and continuing education, with options in the Ph.D. program in extension personnel development, extension program development, extension administration and supervision, continuing education, and community development.

Applicants for the Master of Science program need present only transcripts but may provide other evidence. Those who have not had previous training in education will need to complete eight or 16 credits in education prerequisites, depending on the nature and extent of their professional experience. Both thesis and non-thesis options are available in Master of Science programs.

Applicants for the Doctor of Philosophy program should present transcripts of all previous academic work, a list of references acquainted with their potential for academic success, and results of the Graduate Education Test Battery (Miller Analogies, Cooperative English, and SCAT quantitative tests). 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. Foreign language options include: (a) complete facility in one language, (b) reading knowledge of two languages, or (c) reading knowledge of one language and completion of two designated research courses. Two consecutive semesters of full-time resident study are required.

The Department also offers the A.G.S. Program leading to the Advanced Graduate Specialist Certificate. It requires 30 credits beyond the master's degree.

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

For Graduates and Advanced Undergraduates

RLED 114. Rural Life in Modern Society. (3)
Second semester (Longest)

RLED 150. Extension Education. (2)
Second semester (Ryden)

RLED 160. Extension Communications. (2)
First semester (Ryden)

RLED 170, 171. Conservation of Natural Resources. (3, 3)
Designed primarily for teachers. Study of state's natural resources—soil, water, fisheries, wildlife, forests and animals—natural resource problems and practices. Extensive field study. First course concentrates on subject matter; second includes methods of teaching conservation. Courses taken concurrently in summer session. (Staff)

RLED 180, 181. Critique in Rural Education. (1, 1)
Current problems and trends in rural education. (Staff)

RLED 185. Development and Management of Extension Youth Programs. (3)
(Ryden)

For Graduates

RLED 200. 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. (Nelson)

RLED 201. Rural Community Analysis. (3)
First semester. Analysis of structure and function of rural society and application of social understandings to educational processes. (Longest)

RLED 204. 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. (Longest)

RLED 207, 208. Special Topics in Rural Education. (2, 2)
Prerequisite, permission of instructor. (Staff)

RLED 209. Rural Adult Education. (2)
Second semester. Principles of adult education applied to rural groups. Understanding adult motivation, ability and behavior. Effective methods of planning, organizing and conducting rural adult education programs. (Ryden)

RLED 215. 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. (Staff)

RLED 217. 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. (Nelson)

RLED 225. Program Development in Extension Education. (2)
Prerequisite, RLED 150 or equivalent. Principles and procedures of program planning and development in extensive education. (Ryden)

RLED 240. Agricultural College Instruction. (1)
(Staff)

RLED 301. Special Problems in Rural Education. (1-3)
Prerequisite, approval of staff. (Staff)

RLED 302. Seminar in Rural Education. (1, 1)
Second semester. Problems in the organization, administration, and supervision of the several agencies of rural education. Investigation, papers, and reports. (Staff)

RLED 399. Thesis Research. (Master's Level.)
(Staff)

RLED 499. Dissertation Research. (Doctoral Level)
(Staff)

AGRONOMY

CROPS, SOILS, AND GEOLOGY

Professors: Miller, Axley, Decker, Rothgeb, and Strickling.

Associate Professors: Clark, Fanning, Foss, and Schillinger.

Assistant Professors: Aycock, Bandel, Bezdicek, Burt, Parochetti, and Powell.

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

A dissertation based on original research is required for the degree of Doctor of Philosophy. Thesis and non-thesis options are available for the Master of Science degree. Ample laboratory and greenhouse facilities for graduate work are available on the campus. The Plant Research Farm, the Forage Research Farm, and the Tobacco Experiment Farm offer adequate nearby research facilities. Many projects of the Department are conducted in cooperation with the Agricultural Research Service of the United States Department of Agriculture with headquarters located three miles from the campus.

Departmental regulations have been assembled for the guidance of candidates for graduate degrees. Copies of these regulations are available from the Department of Agronomy.

CROPS

For Graduates and Advanced Undergraduates

AGRO 103. Crop Breeding. (3)
First semester, alternate years. (Offered 1970-71.) Prerequisite, BOTN 117 or ZOOL 006. (Schillinger)

AGRO 104. Tobacco Production. (3)
Second semester. Prerequisite, BOTN 001. (Hoyert)

AGRO 107. Cereal Crop Production. (2)
First semester, alternate years. (Offered 1970-71.) Prerequisite, BOTN 001. (Rothgeb)

AGRO 108. Forage Crop Production. (2)
Second semester. Prerequisite BOTN 001. (Decker)

AGRO 109. Turf Management. (3)
First semester, alternate years (Offered 1971-72). Two lectures and one laboratory period per week. Prerequisite, BOTN 001. (Powell)

AGRO 151. Cropping Systems. (2)
First semester. Prerequisite, AGRO 001 or equivalent. (Clark)

AGRO 152. Seed Production and Distribution. (2)
Second semester, alternate years. (Offered 1970-71.) One lecture and one laboratory period a week. Prerequisite, AGRO 001 or equivalent. (Newcomer)

AGRO 154. Weed Control. (3)
First semester, alternate years. (Offered 1971-72.) Two lectures and one laboratory period a week. Prerequisite, AGRO 001 or equivalent. (Parochetti)

For Graduates

AGRO 201, 202. Advanced Crop Breeding. (2, 2)
Alternate years (Offered 1971-72). Prerequisite AGRO 103 or equivalent. Genetic, cytogenetic, and statistical theories underlying methods of plant breeding. A study of quantitative inheritance, herterosis, heritability, interspecific and intergeneric hybridization, polyploidy, sterility mechanisms, inbreeding and outbreeding, and other topics as related to plant breeding. (Schillinger, Aycock)

AGRO 203. Breeding for Resistance to Plant Pests. (3)
Second semester, alternate yeors. (Offered 1970-71). Prerequisite ENTM 20, BOTN 20, and AGRO 103, or permission of instructor. A study of the development of breeding techniques for selecting and utilizing resistance to insects and diseases in crop plants and the effect of resistance on the interrelationships of host and pest. (Schillinger, Vest)

AGRO 204. Technique in Field Crop Research. (2)
Second semester, alternate years. (Offered 1970-71.) Field plot technique, application of statistical analysis to agronomic data, and preparation of the research project. (LeClerg)

AGRO 205. Advanced Tobacco Production. (2)
First semester, alternate years. (Offered 1971-72.) Prerequisite, permission of instructor. A study of the structural adaptation and chemical response of tobacco to environmental variations. Emphasis will be placed on the alkaloids and other unique components. (Hoyert)

AGRO 207. Advanced Forage Crops. (2)
First semester, alternate years. (Offered 1970-71.) Prerequisite, BOTN 101, CHEM 031, 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, air temperoture, humidity, length of day, quality and intensity of light, wind movement, and defoliation practices. Relationship of these foctors to life history, production, chemical and botanical composition, quality, and persistence of forages will be considered. (Decker)

AGRO 208. 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. (Staff)

SOILS

For Graduates and Advanced Undergraduates

AGRO 111. Soil Fertility Principles. (3)
First semester, alternate years. (Offered 1970-71). Prerequisite, AGRO 010. (Strickling)

AGRO 112. Commercial Fertilizers. (3)
Second semester. Prerequisite, AGRO 010 or premission of instructor. (Axley)

AGRO 113. Soil and Water Conservation. (3)
First semester, alternate years. (Offered 1970-71). Two lectures and one laboratory period a week. Prerequisite, AGRO 010 or permission of instructor. (Foss)

AGRO 114. Soil Classification and Geography. (4)
Second semester. Three lectures and one laboratory period a week. Prerequisite, AGRO 010, or permission of instructor. (Fanning)

AGRO 115. Soil Survey and Land Use. (3)
First semester alternate years. (Offered 1971-72). Two lectures and one laboratory a week. Prerequisite, AGRO 114 or consent of the instructor. (F. Miller)

AGRO 116. Soil Chemistry. (3)
First semester, alternate years. (Offered 1970-71). One lecture and two laboratory periods a week. Prerequisite, AGRO 010, or permission of instructor. (Axley)

AGRO 117. Soil Physics. (3)
First semester, alternate years. (Offered 1971-72.) Two lectures and one laboratory period a week. Prerequisites, AGRO 010 and a course in physics, or permission of instructor. (Strickling)

AGRO 118. Soil Biochemistry. (3)
Second semester, alternate years (Offered 1970-71). Two lectures and one laboratory period per week. Prerequisite, AGRO 010, CHEM 033 or 037 and 038 or consent of instructor. (Bezdicek)

For Graduates

AGRO 250. Advanced Soil Mineralogy. (3)
First semester, alternate years. (Offered 1970-71.) Prerequisites, AGRO 010, and permission of instructor. A study of the structure, physical-chemical characteristics and identification methods of soil minerals, particularly clay minerals, and their relationship to soil genesis and productivity. (Fanning)

AGRO 251. Advanced Methods of Soil Investigation. (3)
First semester, alternate years. (Offered 1971-72.) Prerequisites, AGRO 010 and permission of instructor. An advanced study of the theory of the chemical methods of soil investigation with emphasis on problems involving application of physical chemistry. (Axley)

AGRO 252. Advanced Soil Physics. (3)
Second semester, alternate years. (Offered 1971-72.) Prerequisites, AGRO 010 and permission of instructor. An advanced study of physical properties of soils. (Strickling)

AGRO 253. Advanced Soil Chemistry. (3)
Second semester, alternate years. (Offered 1970-71.) One lecture and two laboratory periods a week. Prerequisites, AGRO 010 and permission of instructor. A continuation of AGRO 116 with emphasis on soil chemistry of minor elements necessary for plant growth. (Axley)

CROPS AND SOILS

For Graduates and Advanced Undergraduates

AGRO 198. Special Problems in Agronomy. (1-3) (var. cr.)
First and second semesters. Prerequisites, AGRO 10, 107, 108 or permission of instructor. A detailed study, including a written report of an important problem in agronomy. (Staff)

For Graduates

AGRO 260. 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. (Staff)

AGRO 302. Agronomy Seminar. (1, 1)
First and second semesters. Total credit toward Master of Science degree, 2; toward Ph.D. degree, 6. Prerequisite, permission of instructor. (Staff)

AGRO 399. Thesis Research. (Master's Level) (1-4)
First and second semesters. Credit according to work done. (Staff)

AGRO 499. Dissertation Research. (Doctoral Level) (1-4)
(Staff)

GEOLOGY

For Graduates and Advanced Undergraduates

GEOL 120. Crystallography. (3)
First semester. Two lectures and one two-hour laboratory a week. Prerequisite, CHEM 003 or consent of instructor. (Siegrist)

GEOL 121. Mineralogy. (3)
Second semester. One lecture and two laboratories a week. Prerequisite, GEOL 004 and 120 or consent of instructor. (Siegrist)

GEOL 122. Optical Mineralogy. (3)
First semester, alternate years. (Offered 1970-71) One lecture and two laboratories a week. Prerequisite, GEOL 121 or consent of instructor. (Staff)

GEOL 130. Invertebrate Paleontology. (3)
First semester, alternate years. (Offered 1971-72). Two lectures and one laboratory a week. Prerequisite, GEOL 2 or consent of instructor. ZOOL 2 or equivalent recommended. (Fernow)

GEOL 131. Stratigraphic Paleontology. (3)
Second semester, alternate years. (Offered 1971-72). Two lectures and one laboratory a week. Prerequisite, GEOL 130. (Fernow)

GEOL 140. Structural Geology. (3)
First semester, alternate years. (Offered 1971-72.) Two lectures and one laboratory a week. Prerequisite, GEOL 4 or consent of instructor. (Segovia)

GEOL 141. Sedimentation. (3)
Second semester, alternate years. (Offered 1970-71.) Two lectures and one laboratory a week. Prerequisite, GEOL 4 or consent of instructor. (Stifel)

GEOL 142. Igneous and Metamorphic Petrology. (2)
First semester, alternate years. (Offered 1970-71.) Two laboratories a week. Prerequisites, GEOL 121 or consent of instructor.

GEOL 143. Petrography. (2)
Second semester, alternate years. (Offered 1970-71.) Two laboratories a week. Prerequisites, GEOL 122, 141, 142 or consent of instructor.

GEOL 145. Geochemistry. (3)
First semester. Prerequisite, GEOL 121 or consent of instructor.

GEOL 147. Geophysics. (3)
Second semester, alternate years. Offered (1971-72.) Two lectures and one laboratory a week. Prerequisite, PHYS 11 or consent of instructor.

GEOL 150. Groundwater Geology. (3)
First semester, alternate years. (Offered 1970-71.) Prerequisite, GEOL 1 or consent of instructor.

GEOL 151. Marine Geology. (3)
Second semester, alternate years. (Offered 1970-71.) Prerequisite, GEOL 1 or consent of instructor.

GEOL 152. Economic Geology I—Metallic Ore Deposits. (2)
First semester, alternate years. (Offered 1970-71.) Two laboratories a week. Prerequisite, GEOL 121 or consent of instructor.

GEOL 153. Economic Geology II—Non-Metallic Ore Deposits. (2)
Second semester, alternate years. (Offered 1970-71.) Two laboratories a week. Prerequisite, GEOL 121 or consent of instructor.

GEOL 154. Engineering Geology. (3)
Second semester, alternate years. (Offered 1971-72.) Two lectures and one laboratory a week. Prerequisite, GEOL 4 or consent of instructor. (Segovia)

GEOL 160. Earth Science. (3)
First semester. Two lectures and one laboratory a week. Prerequisite, permission of instructor. (Maccini)

GEOL 194. Research Problems in Geology. (1)
First and second semester. Open only to geology majors in their final year. (Staff)

GEOL 197. Special Topics in Earth Science. (1-3)
Second semester. Prerequisite, GEOL 160 or equivalent. (Maccini)

GEOL 198. Special Problems in Geology. (1-3)
First and second semesters. Prerequisites, GEOL 002 and GEOL 004, or equivalent, and consent of instructor. Intensive study of a special geologic subject or technique selected after consultation with instructor. Intended to provide training or instruction not available in other courses which will aid the student's development in his field of major interest. (Staff)

AMERICAN STUDIES

Professor: Beall *(Director of the Program).*
Assistant Professors: Lounsbury, and Mintz.
Lecturers: Skramstad, and Washburn.

The American Studies Program offers work leading to both the degrees of Master of Arts and Doctor of Philosophy. The Departments of English, History, Art, and Philosophy join to offer integrated plans of study. In his class work the student will emphasize the offerings of any one of these departments; either English or history must be included within his field of emphasis. For the lists of courses from which his program is to be developed, he is to see principally the listings of the four departments just mentioned. The director of the program will serve as the student's adviser. The American Studies Program collaborates with the Smithsonian Institution's Department of American Studies.

For Graduates and Advanced Undergraduates

AMST 127, 128. Culture and the Arts in America. (3, 3)
First and second semesters. (Lounsbury)

AMST 137, 138. Readings in American Studies. (3, 3)
First and second semesters. (Mintz)

For Graduates

AMST 200. Introductory Seminar in American Studies. (3)
(Beall, Lounsbury)

AMST 201, 202. Seminar in American Studies. (3, 3)
(Beall, Mintz, Lounsbury)

AMST 251. Orientation Seminar—Material Aspects of American Civilization. (3)
Class meets at the Smithsonian. (Skramstad)

AMST 255. Supervised Study in Selected Subject Fields. (3)
Class meets at the Smithsonian. (Staff)

AMST 299. Thesis Research. (1-6)
Class meets at the Smithsonian. (Staff)

AMST 399. Thesis Research. (Master's Level)
(Staff)

AMST 499. Dissertation Research. (Doctoral Level)
(Staff)

ANIMAL SCIENCE

Professors: Foster *(Emeritus)*, Green, Leffel, and Young.

Associate Professor: Buric.

Assistant Professor: DeBarthe.

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

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

For Graduates and Advanced Undergraduates

ANSC 109. Fundamentals of Nutrition. (3)
See Poultry Science for description. (Thomas)

ANSC 110. Applied Animal Nutrition. (3)
See Dairy Science for description. (Vandersall)

ANSC 116. Anatomy of Domestic Animals. (3)
First semester. One lecture and two laboratory periods per week. A systematic comparative study of the pig, ruminants and fowl with special emphasis of those systems important in animal production. Prerequisite, ZOOL 001. (Albert)

ANSC 117. Introduction to Diseases of Animals. (3)
Second semester. Two lectures and one laboratory period per week. Prerequisites, MICR 001 and ZOOL 001. (Albert)

ANSC 118. Wildlife Management. (3)
Second semester. Two lectures and one laboratory. (Flyger)

ANSC 120. Advanced Livestock Judging. (2)
First semester. Two laboratory periods per week. Prerequisites, ANSC 022 and permission of instructor. An advanced course in the selection and judging of purebred and commercial meat animals. The most adept students enrolled in the course are chosen to represent the University of Maryland in Intercollegiate Livestock Judging Contests. (Buric)

ANSC 121. Meats. (3)
Second semester. Two lectures and one laboratory period per week. Prerequisite, ANSC 020. Registration limited to 14 students. Laboratory periods are conducted in packing houses, meat distribution centers, and retail outlets. (Buric)

ANSC 122. Livestock Management. (3)
First semester. One lecture and two laboratory periods per week. Prerequisite, ANSC 109. (Staff)

ANSC 123. Livestock Management. (3)
Second semester. One lecture and two laboratory periods per week. Prerequisite, ANSC 122. (Leffel)

ANSC 130. Principles of Breeding. (3)
Second semester. Three lectures per week. Prerequisite, ZOOL 006 or BOTN 117. ANSC 122 or 123 or ANSC 022. Graduate credit (1-3 hours) allowed with permission of instructor. (Green)

ANSC S131. Special Topics in Animal Science. (1)
Prerequisite, permission of instructor. Summer session only. This course is designed primarily for teachers of vocational agricultural and Extension Service personnel. One primary topic to be selected mutually by the instructor and students, will be presented each session.

ANSC 140. Physiology of Mammalian Reproduction. (2)
See Dairy Science for description. (Williams)

ANSC 141. Physiology of Milk Secretion. (2)
See Dairy Science for description. (Williams)

ANSC 142. Dairy Cattle Breeding. (3)
See Dairy Science for description. (Plowman)

ANSC S143. Advanced Dairy Production. (1)
See Dairy Science for description. (Staff)

ANSC 160. Technology of Market Eggs and Poultry. (3)
See Poultry Science for description. (Helbacka)

ANSC 162. Avian Physiology. (2)
See Poultry Science for description.

ANSC S163. Poultry Breeding and Feeding. (1)
See Poultry Science for description. (Combs)

ANSC S164. Poultry Products and Marketing. (1)
See Poultry Science for description. (Helbacka)

ANSC 165. Physiology of Hatchability. (1)
See Poultry Science for description. (Shaffner)

ANSC 170. Poultry Hygiene. (3)
See Poultry Science for description. (Newman)

ANSC 171. Avian Anatomy. (3)
See Poultry Science for description. (Newman)

ANSC 198. Special Problems in Animal Science. (1-2) (4 cr. max.)
First and second semester. Prerequisite, approval of staff. Work assigned in proportion to amount of credit. A course designed for advanced undergraduates in which specific problems relating to animal science will be assigned. (Staff)

ANSC 199. Seminar. (1)
Second semester. Prerequisite, permission of staff. Presentation and discussion of current literature and research work in animal science. (Staff)

(Attention is called to AGEC 117, Economics of Marketing Eggs and Poultry (3) [See Agricultural Economics]; and FDSC 125, Meat and Meat Processing (3) [See Food Science].

For Graduates

ANSC 200. Electron Microscopy. (2)
(Mohanty)

ANSC 220. Advanced Breeding. (2)
Second semester, alternate years. Two lectures a week. Prerequisites, ANSC 130 or equivalent, and Biological Statistics. This course deals with the more technical phases of heredity and variation, selection indices, breeding systems, and inheritance in farm animals. (Green)

ANSC 221. Energy and Protein Nutrition. (3)
Second semester. Prerequisites, CHEM 031 and 033, or equivalent, ANSC 109 or permission of Instructor. Three lectures per week. A study of animal energetics and the basic descriptions of animals relative to the requirements for energy and protein. Literature dealing with nutrition research techniques and energy and protein utilization and requirements is surveyed. (Leffel)

ANSC 240. Advanced Ruminant Nutrition. (2)
See Dairy Science for description. (Vandersall)

ANSC 241. Research Methods. (3)
See Dairy Science for description.

ANSC 242. Experimental Mammalian Surgery I. (2)
See Dairy Science for description.

ANSC 243. Experimental Mammalian Surgery II. (3)
See Dairy Science for description.

ANSC 261. Physiology of Reproduction. (3)
See Poultry Science for description. (Shaffner)

ANSC 262. Poultry Literature. (1-4)
See Poultry Science for description. (Staff)

ANSC 263S. Poultry Nutrition Laboratory. (2)
See Poultry Science for description. (Creek)

ANSC 264. Vitamins. (2)
See Poultry Science for description. (Thomas)

ANSC 265. Mineral Metabolism. (2)
See Poultry Science for description. (Bull)

ANSC 301. Special Problems in Animal Science. (1-2) (4 cr. max.)
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. (Staff)

ANSC 302. Seminar. (1) (5 cr. max.)
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; (2) Nutrition; (3) Physiology; (4) Biochemistry. (Staff)

ANSC 399. Thesis Research. (Master's Level)
First and second semesters. Work assigned in proportion to amount of credit. Students will be required to pursue original research in some phase of animal science, carrying the same to completion, and report the results in the form of a thesis. (Staff)

ANSC 499. Dissertation Research. (Doctoral Level)
(Staff)

ART

Professor and Chairman: Levitine.
Professors: deLeiris, Lembach, Lynch, and Maril.
Associate Professors: Denny, Jamieson, Longley, Rearick, and Stites.
Assistant Professors: Bunts, Forbes, Freeney, Isen, Mirolli, Niese, O'Connor, and Pemberton.
Lecturers: Banks, Campbell, Griffin, Kainen, and Landgren.

The Department of Art offers graduate programs of study leading to the degrees of Master of Arts in art history and studio art and Doctor of Philosophy in art history. The major in art history is committed to the advanced study and scholarly interpretation of existing works of art, from the prehistoric era to our times, while the studio major stresses the student's direct participation in the creation of works of art. 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.

A limited number of fellowships and graduate assistantships are available in art. Interested students should apply to the Department of Art.

History of Art Major

For admission to graduate study in art history, in addition to the approved undergraduate degree, or its equivalent, special Departmental requirements must be met.

I. Master of Arts in Art History
Departmental Requirements:
1. Art 280 is required.

2. A reading knowledge of French or German (examination administered by The Graduate School.)
3. A written comprehensive examination which tests the candidate's knowledge and comprehension of principal areas and phases of art history.
4. A thesis which should demonstrate competency in research and in original investigation by the candidate.
5. A final oral examination on the thesis and the field which it represents.

II. Doctor of Philosophy in Art History
1. Art 280 is required.
2. A reading knowledge of two foreign languages, one of which must be either French or German (examination administered by The Graduate School.)
3. A written qualifying examination covering four fields of specialization including the student's own major field. The choice of fields presented for examination is made by the student in consultation with his adviser. This examination is preparatory to admission to candidacy. Course and language requirements must have been completed prior to taking examination.
4. Dissertation which should demonstrate candidate's capacity to perform independent research in the field of art history.
5. A final oral examination on dissertation and the field it represents.

Studio Major

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. In addition, special Departmental requirements must be met. A portfolio and/or slides should be submitted to the Department along with application for admission. Candidate for the master's degree will be required to pass a written comprehensive examination, and submit a thesis or an original creative project in painting, drawing, sculpture, or print making.

For information on work leading to the degrees of Master of Arts or Master of Education in art education, the student is referred to the section devoted to the Department of Education in this catalog.

For Graduates and Advanced Undergraduates

ART 117. Painting II. (3)
Six hours per week. Prerequisites. ART 017, 026. Original compositions based upon nature, figure and still life, supplemented by expressive painting. Choice of media. Different sections of course may be taken for credit.
117-a. Oil painting and related media. (Maril)
117-b. Watercolor and casein. (Staff)
117-c. Plastic media, such as encaustic and polymer tempera. (Jamieson)
117-d. Mural painting. The use of contemporary synthetic media. (Jamieson)

ART 118. Sculpture I. (3)
Six hours per week. Prerequisite, ART 026. (For student majoring in Art History, by permission of Department.) (Freeny)

ART 119. Printmaking I. (3)
Six hours per week. Prerequisite, ART 026. (For student majoring in Art History, by

permission of Department.) Basic printmaking technique in relief, intaglio, and planographic media. (Forbes, Isen)

ART 126. Drawing III. (3)
Six hours per week. Prerequisite, ART 026. Emphasis on understanding organic form, as it is related to study from the human figure and to pictorial composition. (Jamieson)

ART 127. Painting III. (3)
Six hours per week. Prerequisite, ART 117. Creative painting for advanced students. Problems require a knowledge of pictorial structure. Development of personal direction. Choice of media. (Staff)

ART 128. Sculpture II. (3)
Six hours per week. Prerequisite, ART 118. Different sections of course may be taken for credit.
128-a. Nature as a point of reference with potentiality of developing ideas into organic and architectural forms. (Freeny)
128-b. May be taken after 128-a. Problems involving plastic earths and other material capable of being modeled or cast. Choice of individual style encouraged. (Freeny)

ART 129. Printmaking II. (3)
Six hours per week. Prerequisite, ART 119. One print media including extensive study of color processes. Individually structured problems. (Forbes, Isen)

ART 136. Drawing IV. (3)

ART 137. Painting IV. (3)
Six hours per week. Prerequisite, ART 127. Creative painting. Emphasis on personal direction and self-criticism. Group seminars. (Jameison, Maril, Staff)

ART 138. Sculpture III. (3)
Six hours per week. Prerequisite, ART 128. Problems and techniques of newer concepts, utilizing various materials, such as: plastics and metals. Technical aspects of welding stressed. (Freeny)

ART 139. Printmaking III. (3)
Six hours per week. Prerequisite, ART 129.
139-a. Contemporary experimental techniques of one print medium with group discussions. (Forbes, Isen)
139-b. Continuation of 139-a. May be taken for credit after 139-a. (Forbes, Isen)

ART 150, 151. Spanish Art. (3, 3)
Special emphasis will be given to the artists of the 16th and 17th centuries, such as El Greco and Velasquez. (Lynch)

ART 152, 153. Latin American Art. (3)
(Lynch)

ART 155. American Colonial Painting. (3)
(Staff)

ART 157. American Art and its Relationship to Europe: 1800-1900. (3)
Prerequisite, ART 060 and 061 recommended. The American artist in Europe; American and German Romanticism; Neo-Classicism in America and Europe; Düsseldorf School; Munich School; Pre-Raphaelism, Barbizon School and Impressionism. (Gerdts.)

ART 158, 159. History of American Art. (3, 3)
Architecture, sculpture, and painting in the United States from the Colonial period to the present. (Herban)

ART 160, 161. Classical Art. (3, 3)
Architecture, sculpture and painting in the classical cultures. First semester will stress Greece; second semester, Rome. (Pemberton)

ART 162, 163. Art of the East. (3, 3)
Architecture, sculpture and painting. First semester will stress India; second semester, China and Japan. (Griffin)

ART 164. Early Christian and Byzantine Art. (3)
Architecture, sculpture, painting, and mosaic of early Christian Rome, the near East, and the Byzantine Empire. (Staff)

ART 166, 167. Medieval Art. (3, 3)
Architecture, sculpture and painting in the Middle Ages. First semester will stress Romanesque; second semester, the Gothic period. (Denny)

ART 168, 169. Renaissance Art in Italy. (3, 3)
Architecture, sculpture and painting from 1400 to the High Renaissance in the 16th century. (Rearick)

ART 170, 171. Northern European Painting in the 15th and 16th Centuries. (3, 3)
Includes the Netherlands, France and Germany. (Staff)

ART 172, 173. European Baroque Art. (3, 3)
Architecture, sculpture, and painting of the major European centers in the 17th century. (de Leiris)

ART 174, 175. French Painting. (3, 3)
French painting from the 15th through the 18th century, from Fouquet to David. (Levitine)

ART 176, 177. 19th Century European Art. (3, 3)
Arhcitecture, sculpture and painting in European Art from Neo-Classicism to Impressionism. (de Leiris)

ART 178, 179. 20th Century Art. (3, 3)
Architecture, sculpture and painting from the late 18th century to our day. (O'Connor)

ART 180. Impressionism and Neo-Impressionism. (3)
Prerequisite, ART 060 and 061 or consent of instructor. History of Impressionism and Neo-Impressionism: artists, styles, art theories, criticism, sources and influence on twentieth century. (de Leiris)

ART 182. Twentieth Century Masters and Movements. (3)
Artists and tendencies in twentieth century art. Subject will change and be announced each time course is offered. (O'Connor)

ART 184. History of the Graphic Arts. (3)
Prerequisite, ART 010 or ART 060, 061, or consent of instructor. Graphic techniques and styles in Europe from 1400 to 1800; contributions of major artists. (Levitine)

ART 192, 193. Directed Studies in Studio Art. (2 or 3, 2 or 3)
For advanced students, by permission of Department Head. Course may be repeated for credit if content differs. (Staff)

ART 194, 195. Directed Studies in Art History. (2 or 3, 2 or 3)
For advanced students, by permission of Department Head, Course may be repeated for credit if content differs. (Staff)

For Graduates

The requirements of students will determine which courses will be offered.

ART 200, 201. Painting. (3, 3)
Specific projects to be developed. Conferences arranged. (Jamieson, Maril)

ART 202,203. Painting. (3, 3)
Individual projects growing in complexity. Seminars. (Jamieson, Maril)

ART 211. Printmaking. (3)
Advanced problems. Relief process. (Forbes, Isen)

ART 212. Printmaking. (3)
Advanced problems. Intaglio process. (Forbes, Isen)

ART 213. Printmaking. (3)
Advanced problems. Lithographic process. (Forbes, Isen)

ART 214. Seminar in Printmaking. (3)
(Forbes, Isen)

ART 221, 222. Experimentation in Sculpture. (3, 3)
Independent research stressed. (Freeny)

ART 223. 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. (Freeny)

ART 224. Sculpture—Casting and Foundry. (3)
The traditional methods of plaster casting and the more complicated types involving metal. *Cire perdue*, sand-casting and newer methods, such as cold metal process.
(Freeny)

ART 226. Drawing. (3)
Sustained treatment of a theme chosen by student. Wide variety of media. (Jamieson)

ART 227. Drawing. (3)
Traditional materials and methods including Oriental, Sumi ink drawing and techniques of Classical European masters. (Jamieson)

ART 228 Drawing. (3)
Detailed anatomical study of the human figure and preparation of large scale mural compositions. (Jamieson)

ART 229. Drawing and Painting. (3)
Preparation and execution of a wall decoration. (Jamieson)

ART 240, 241. Advanced Problems in Art Education. (3, 3)
An integrated series of problems determined by the student's professional needs.
(Lembach)

ART 250. American Colonial Art. (3)
The arts during the exploration period and Colonial development. (Staff)

ART 255. Seminar in 19th Century American Art. (3)
Problems in architecture and painting from the end of the Colonial period until 1860.
(Staff)

ART 256. Twentieth Century American Art. (3)
Prerequisite, ART 178, 179 or equivalent. The "Eight," the Armory Show, American Abstraction, Romantic-Realism, New Deal Art projects, American Surrealism and Expressionism. (O'Connor)

ART 257. Seminar in American Art and Its Literary Sources. (3)
Prerequisite, ART 060 and 061 or equivalent. Art and literature in the 19th century; literary influences on 19th century American painting artistic and literary parallels; art theories and criticism by authors and artists. (Staff)

ART 258. Seminar in Local and Regional Art. (3)
Prerequisite, ART 060 and 061 or equivalent. Art in Washington, D. C., Baltimore and the State of Maryland. Major genres; prominent artists; public commissions; institutions. (Staff)

ART 259. The Art of Mannerism. (3)
Prerequisite, ART 169 or permission of instructor. Mannerism in Europe during the 16th century; beginnings in Italy; ramifications in France, Germany, Flanders, Spain; painting, architecture, and sculpture. (Lynch

ART 260. French Painting From Lebrun to Gericault—1715-1815. (3)
Development of iconography and style from the Baroque to Neo-Classicism and Romanticism. Trends and major artists. (Levitine)

ART 261. Seminar in Romanticism. (3)
Problems derived from the development of Romantic Art during the 18th and 19th centuries. (Levitine)

ART 262. Seminar in 18th Century European Art. (3)
(Levitine)

ART 263. Seminar in 19th Century European Art. (3)
Problems derived from the period starting with David and ending with Cezanne. (de Leiris)

ART 264. Nineteenth Century Realism—1830-1860. (3)
Prerequisite, ART 176 or 177 or equivalent. Courbet and the problem of Realism; precursors, David, Gericault, Landscape schools; Manet; artistic and social theories; Realism outside France. (de Leiris)

ART 265. Seminar in Post-Impressionism and Symbolism. (3)
Prerequisite, ART 176 or 177 or equivalent. The period of 1880-1900; Cezanne, van Gogh, Gauguin, the Nabis; Symbolism and Art Nouveau; social and aesthetic theories; formal and functional approaches to architecture. (de Leiris)

ART 266. Seminar in Contemporary Art. (3)
Problems of Western art from 1900 to the present. (O'Connor)

ART 267. Twentieth Century European Art. (3)
Prerequisite, ART 178, 179 or equivalent. A detailed examination of the art of an individual country in the twentieth century: France, Germany, Italy, Spain, England. (O'Connor)

ART 268. Seminar in Literary Sources of Art History. (3)
Art historical sources from Pliny to Malraux. (Levitine)

ART 269. Seminar in Classical Art. (3)
Prerequisite, ART 160, 161 or permission of instructor. (Pemberton)

ART 270. Seminar in Medieval Art. (3)
Prerequisite, ART 166 or 167 or permission of instructor. (Denny)

ART 272. Seminar—Problems in Medieval Iconography. (3)
Prerequisite, ART 166 or 167 or permission of instructor. Studies of selected problems in the religious meaning of Medieval iconography. Some reading knowledge of French, German and Latin is desirable. (Denny)

ART 274. 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. (Denny)

ART 276. Gothic Art. (3)
Painting and sculpture in Western Europe in the 13th and 14th centuries; regional styles; relationships between styles of painting and sculpture; religious content. (Denny)

ART 280. 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. (Landgren)

ART 282, 283. Museum Training Program. (3,3)
Year course. Open to one or two selected students. Theory and practice. Students will be directly involved in all phases of the Department's Gallery Exhibition program (research, planning, exhibition, catalogue). (Landgren)

ART 284. Seminar—Problems in Architectural History and Criticism. (3) (Staff)

ART 286. Seminar in Latin American Art. (3)
Prerequisite, ART 153 or permission of instructor. (Lynch)

ART 288. Seminar in Modern Art. (3)
Prerequisite, ART 153 or permission of instructor. Problems of Mexican art of the 19th and 20th centuries; Mexicanismo; the "Mural Renaissance"; architectural regionalism. (Lynch)

ART 292, 293. Directed Graduate Studies in Studio Art. (3, 3)
For advanced graduate students by permission of Head of Department. Course may be repeated for credit if content differs. (Staff)

ART 294, 295. Directed Graduate Studies in Art History. (3,3)
For advanced graduate students, by permission of Head of Department. Course may be repeated for credit if content differs. (Staff)

ART 399. Thesis Research. (Master's Level)

ART 499. Dissertation Research. (Doctoral Level)

ASTRONOMY

Professors: Westerhout (*Director*), Erickson, Kundu, Kerr, and Opik.
Associate Professors: Bell, Matthews, v. P. Smith, Wentzel, and Zipoy.
Part-Time Professors. Brandt and Musen.
Assistant Professors: A'Hearn, Harrington, Simonson, and Zuckerman.

The Astronomy Program, administratively part of the Department of Physics and Astronomy, is offering a program of study leading to the degrees of M.S. and Ph.D. in astronomy.

It is normally expected that the following subjects should have been studied previous 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 considerably more rapidly during the first year of graduate work. It is recommended that those new students who have little knowledge of astronomy spend part of the summer brushing up on their elementary astronomy.

Graduate Record Examination.

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.

The Ph.D. Qualifying Examination.

The Ph.D. Qualifying Examination is offered each year in September and has to be taken each year by all astronomy students working toward a Doctor of Philosophy degree who have passed the Preliminary Examination and completed one year of graduate study. The normal time limit for passing for full-time students is two years; for part-time students it is four years. The time limit for obtaining the Doctor of Philosophy is seven years for full-time and eight years for part-time students. For the Master of Science, the time limit is five years.

Study Program.

All candidates must obtain three credits of ASTR 100 or ASTR 102, preferably both, for an advanced degree. This requirement may be waived if the student has previous experience. All students should take at least two credits of ASTR 230, Astronomy Seminar. All full-time graduate students are expected to take or audit ASTR 230 each term. No other astronomy courses are specifically required, but candidates for the Doctor of Philosophy should expect to take at least 12 credits of astronomy courses at the 200-level, exclusive of ASTR 230, in order to pass the Qualifying Examination.

Many of the advanced astronomy courses will be offered once every other year, which should be taken into account when individual study programs are considered. Students are urged to acquire a broad background in all fields of astronomy in addition to their field of specialization.

Normally, all Ph.D. candidates take at least 12 credits of advanced physics courses; PHYS 100 through 107 and PHYS 118-119 are not considered advanced. Especially recommended are:

Physics 204, Methods of Mathematical Physics (4)
Physics 205, Electrodynamics (3)
Physics 212, Introduction to Quantum Mechanics (3)

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.

The Department also offers Master of Science and Doctor of Philosophy de-

grees based on a program in Astrophysics. The study program for these degrees can be carefuly adjusted to give the optimum proportion of physics and astronomy courses suitable for some particular borderline field of study. Students majoring in astrophysics will have the option of taking the qualifying examination in either physics, astronomy, or astrophysics.

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, Md. 20742.

For Graduates and Advanced Undergraduates

ASTR 100, 110. Observational Astronomy. (3)

This is a 2-semester course; the two semesters have to be taken consecutively fall and spring. Two lectures per week plus laboratory work at times to be arranged. The laboratory work will sometimes involve all night observing sessions. Prerequisites: working knowledge of calculus, physics through PHYS 018, three 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 telescopes and 21-cm iine spectroscopy, flux measurements and interferometry with the Department's radio telescopes. Laboratory fee, $12.00.

(A'Hearn, Westerhout, Erickson)

ASTR 101. Introduction to Galactic Research. (3)

Three lectures per week. Prerequisite. MATH 021 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, evolution; statistical parallax, distance determination, galactic rotation and structure, high velocity stars, stellar populations. (Kerr, Simonson)

ASTR 102. Introduction to Astrophysics. (3)

Three lectures per week. Prerequisite, previous or concurrent enrollment in PHYS 119 or consent of instructor. Spectroscopy, structure of atmospheres of the sun and other stars. Observational data and curves of growth. Chemical composition.

(Harrington, Bell, Zipoy)

ASTR 124. Introduction to Celestial Mechanics. (3)

Prerequisite, PHYS 127 or consent of the instructor. Newton's Law of Gravitation; two-body problem and its integrals; Kepler's laws; elements of an orbit, determination of the position and velocity vectors from elements and vice versa. Determination of an orbit from observations: Gaussian and Laplacian methods. Orbit correction methods. Perturbations in co-ordinates elements. Computation of satellite orbits, including perturbations. (Musen)

ASTR 150. Special Problems in Astronomy.

(Credit according to work done)

Prerequisites, major in astronomy or physics and consent of one of the members of the astronomy staff. Research or special study. Laboratory fee, $12.00 per credit hour when appropriate. (Staff)

ASTR 190. Honors Seminar.

(Credit according to work done)

Each semester. Enrollment is limited to students admitted to the Honors Program in astronomy. (Staff)

For Graduates

ASTR 200. Dynamics of Stellar Systems. (3)
Three lectures per week. Prerequisite, PHYS 200 or ASTR 101. Study of the structure and evolution of dynamical systems encountered in astronomy. Stellar encounters viewed as a two-body problem, statistical treatment of encounters, Study of dynamical problems in connection with star clusters, ellipsoidal galaxies, nuclei of galaxies, high-velocity stars. (Staff)

ASTR 202. Stellar Interiors. (3)
Three lectures per week. Prerequisites, MATH 114 and PHYS 119 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. (Bell, Wentzel)

ASTR 203. Stellar Atmospheres. (3)
Three lectures per week. Prerequisite, PHYS 212 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. (Bell)

ASTR 204. Physics of the Solar System. (3)
Three lectures per week. Prerequisite, PHYS 119. 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. (Opik, Brandt)

ASTR 210. Galactic Radio Astronomy. (3)
Three lectures per week. Prerequisite, PHYS 119, ASTR 101, 110 or consent of the instructor. Theory and observation of the continuum and line emission from the Galaxy. Galactic structure derived from radio observations, comparison with optical data. The rotation of the Galaxy. The galactic halo, the nucleus, proposed mechanisms. (Westerhout, Kerr)

ASTR 212. Physics of the Solar Envelope. (3)
Three lectures per week. Prerequisites. PHYS 119, ASTR 102 or consent of the instructor. A detailed study of the solar atmosphere. Physics of solar phenomena, such as solar flares, structure of the corona, etc. (Erickson, Kundu, v. P. Smith)

ASTR 214. Interstellar Matter. (3)
Three lectures per week. Prerequisites, previous or concurrent enrollment in PHYS 212, ASTR 101 or ASTR 102 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. (Wentzel, Zuckerman)

ASTR 230. Seminar. (1)
Seminars on various topics in advanced astronomy are held each semester, with the contents varied each year. One credit for each seminar each semester. There are weekly colloquia by staff, astronomers from the Washington area, and visiting astronomers, usually on topics related to their own work. (Staff, Visitors)

ASTR 248, 249. Special Topics in Modern Astronomy.
Credit according to work done each semester. Prerequisite, consent of instructor. These courses will be given by specialists in various fields of modern astronomy, partly staff members, partly visiting professor or part-time lecturers. They will cover subjects such as: cosmology, discrete radio sources, magnetohydrodynamics in astronomy, the H.R.

diagram, stellar evolution, external galaxies, galactic structure, chemistry of the interstellar medium, advanced celestial mechanics, astrometry, radio physics of the sun, etc. (Staff, Visiting Astronomers)

ASTR 399. Thesis Research. (Master's Level)
Credit according to work done each semester. Prerequisite, an approved application for admission to candidacy or special permission of the Astronomy Program.

ASTR 499. Dissertation Research. (Doctoral Level)

BOTANY

Professor and Head: Krauss.
Professors: Corbett, Galloway, Gauch, Kantzes, Krusberg, D. T. Morgan, Sisler, Stern, and Weaver.
Research Professor: Sorokin.
Associate Professors: Brown, Karlander, Klarman, Lockard, O. D. Morgan, Patterson, and Rappleye.
Assistant Professors: Barnett, Bean, Curtis, Harrison, Motta, Reveal, Smith, and Terbargh.
Instructors: Grigg and Owens.

The Department of Botany offers graduate courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The student may pursue major work in plant physiology, plant pathology, plant ecology, plant taxonomy, nematology, cytogenetics, biochemical genetics, or plant anatomy. Inasmuch as a thesis based on original research is required for each degree, a qualified student may be allowed to pursue a problem of his own choosing or choose some area of research in progress since the Department is devoted to a study of basic biological problems as well as some projects of an applied nature.

GENERAL BOTANY

BOTN 136. Plants and Mankind. (2)
First semester. Prerequisites, BOTN 001 or equivalent. A survey of the plants which are utilized by man, the diversity of such utilization, and their historic and economic significance.

BOTN 151S. Teaching Methods in Botany. (2)
Summer session. Four two-hour laboratory demonstration periods per week for eight weeks. Prerequisite, BOTN 001, or equivalent. (Lockard)

BOTN 171. Marine Plant Biology. (4)
Summer session. Prerequisite, BOTN 001 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. (Krauss, Staff)

BOTN 301. Special Problems in Botany. (1 to 3)
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. Problems

or topics may be in: 1—Physiology; 2—Ecology; 3—Pathology; 4—Mycology; 5—Nematology; 6—Cytology; 7—Cytogenetics; 8—Morphology; 9—Anatomy; or 10—Taxonomy. (Staff)

BOTN 302. 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. (Staff)

PLANT PHYSIOLOGY

For Graduates and Advanced Undergraduates

BOTN 101. Plant Physiology. (4)
First semester. Two lectures and one 4-hour laboratory period a week. Prerequisites, BOTN 001 and General Chemistry. Organic Chemistry strongly recommended. A survey of the general physiological activities of plants. (Patterson)

For Graduates

BOTN 204. Growth and Development. (2)
First semester. (Not offered 1971-72) 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. (Barnett)

BOTN 209. Physiology of Algae. (2)
Second semester (Not offered 1971-72). Prerequisite, BOTN 231, the equivalent in allied fields, or permission of the instructor. A study of the physiology and comparative biochemistry of the algae. Laboratory techniques and recent advances in algal nutrition, photosynthesis, and growth will be reviewed. (Krauss)

BOTN 210. Physiology of Algae—Laboratory. (1)
Second semester. (Not offered 1971-72). One laboratory period a week. Prerequisites, previous or concurrent enrollment in BOTN 209, and permission of instructor. Special laboratory techniques involved in the study of algal nutrition. (Krauss)

BOTN 230. Advanced Plant Physiology. (2)
First semester. Prerequisites, BOTN 101 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. (Patterson)

BOTN 231. Plant Biochemistry. (2)
Second semester. (Not offered 1970-71). Prerequisite, BOTN 230. A treatment of those aspects of biochemistry especially pertinent to plants—respiration, photosynthesis, and organic transformations. (Galloway)

BOTN 232. Plant Biophysics. (2)
Second semester. (Not offered 1970-71). Prerequisites, BOTN 230 and at least one year of Physics. An advanced course dealing with the operation of physical phenomena in plant life processes. (Karlander)

BOTN 233. Plant Biochemistry-Biophysics Laboratory. (4)
Second semester. (Not offered 1970-71). Prerequisites, BOTN 230 and one year of Physics. Application of physical and chemical techniques and instrumentation to the study of plants. Two four-hour laboratory periods per week. (Karlander and Galloway)

PLANT PATHOLOGY

For Graduates and Advanced Undergraduates

BOTN 122. Research Methods in Plant Pathology. (2)
First semester. Two laboratory periods a week. Prerequisites, BOTN 020, or equivalent. Advanced training in the basic research techniques and methods of plant pathology. (Curtis)

BOTN 127. Diagnosis and Control of Plant Diseases. (3)
Second semester. 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. (Bean)

BOTN 152S. Field Plant Pathology. (1)
Summer session. Daily lecture for three weeks. Prerequisite, BOTN 020, or equivalent. Given in accordance with demand. A course for county agents and teachers of vocational agriculture. Discussion and demonstration of the important diseases in Maryland crops. (Kantzes)

For Graduates

BOTN 221. Plant Virology. (2)
Second semester. (Not offered 1971-72). Two lectures per week on the biological, biochemical, and biophysical aspects of viruses and virus diseases of plants. Prerequisites, Bachelor's degree or equivalent in any biological science and permission of instructor. (Corbett)

BOTN 222. Plant Virology Laboratory. (2)
Second semester. (Not offered 1971-72). 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 221 or concurrent registration therein, and permission of the instructor. (Corbett)

BOTN 223. Physiology of Fungi. (2)
First semester. (Not offered 1971-72). Prerequisites, Organic Chemistry and BOTN 101 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. (Sisler)

BOTN 224. Physiology of Fungi Laboratory. (1)
First semester. (Not offered 1971-72). One laboratory period per week. Prerequisites, BOTN 223 or concurrent registration therein. Application of equipment and techniques in the study of fungal physiology. (Sisler)

BOTN 227. Physiology of Pathogens and Host-Pathogen Relationships. (3)
(Not offered 1970-71). 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. (Curtis, Staff)

BOTN 241. Plant Nematology. (4)
Second semester. Two lectures and two laboratory periods a week. Prerequisite, BOTN 020 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. (Krusberg)

TAXONOMY

BOTN 128. Mycology. (4)
Second semester. (Not offered 1971-72). (Motta)

BOTN 153. Field Botany and Taxonomy. (2)
Summer session. Prerequisites, BOTN 001 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. (Brown)

BOTN 161. Systematic Botany. (2)
First semester. (Not offered 1970-71). Two two-hour laboratory periods a week. Prerequisite, BOTN 011 or equivalent. Laboratory practice with difficult plant families including grasses, sedges, legumes, and composites. Field trips arranged. (Brown)

BOTN 102. Plant Ecology. (2)
Second semester. Prerequisite, BOTN 001. 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 terrestrial and aquatic. (Terborgh)

BOTN 103. Plant Ecology Laboratory. (1)
Prerequisite, BOTN 102 or its equivalent or concurrent enrollment therein. One three-hour laboratory period a week. The application of field and experimental methods to the qualitative and quantitive study of vegetation and environmental factors. (Terborgh)

BOTN 113. Plant Geography. (2)
First semester, Prerequisite, BOTN 001, or equivalent. (Brown)

BOTN 219. Advanced Plant Ecology. (3)
Fall semester. (Not offered 1971-72). Prerequisites, 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. (Terborgh)

PLANT MORPHOLOGY, ANATOMY

For Graduates and Advanced Undergraduates

BOTN 110. Plant Microtechnique. (3)
Second semester. One lecture a week. Laboratory periods by arrangement. Prerequisite, BOTN 001 or equivalent and permission of instructor. Preparation of temporary and permanent mounts, including selection of material, killing and fixing, embedding, sectioning, and staining methods; photomicrography, film and paper processing and preparation of photographic illustrations for research publication. (Stern)

BOTN 111. Plant Anatomy. (3)
First semester. One lecture and two laboratory periods a week. Prerequisite, BOTN 110, or equivalent. (Rappleye)

BOTN 115. Structure of Economic Plants. (3)
Second semester. (Not offered 1971-72). One lecture and two laboratory periods a week. Prerequisite, BOTN 111. (Rappleye)

For Graduates

BOTN 212. Plant Morphology. (3)
Second semester. One lecture and two laboratory periods a week. Prerequisites, BOTN 011, BOTN 111, or equivalent. A comparative study of the morphology of the flowering plants, with special reference to the phylogeny and development of floral organs. (Rappleye)

GENETICS

BOTN 117. General Plant Genetics. (2)
Second semester. Prerequisites, BOTN 001 or equivalent. (Smith)

BOTN 215. 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. (D. T. Morgan)

BOTN 216. Nucleic Acids and Molecular Genetics. (2)
Fall semester. Alternate years. Offered 1970-71. Prequisite: Biochemistry and Cytogenetics. 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 assignment reports on progress in the chemistry of inheritance. (Smith)

BOTN 399. Thesis Research. (Master's Level)
Credit according to work done. A minimum of 6 credit hours is required for the M.S. degree, and an additional minimum of 12 hours is required for the Ph.D. degree. Students must be qualified to pursue with profit the research to be undertaken. (Staff)

BOTN 499. Dissertation Research. (Doctoral Level)

BUSINESS ADMINISTRATION

Professors: Anderson, Carroll, Dawson, Fisher, Hermanson, Miner, Taff, and Wright.
Associate Professors: Ashmen, Greer, Haslem, Hille, Hynes, Lamone, Levine, Nash, Paine, and Spivey.
Assistant Professors: Falthzik, Gannon, Hargrove, Himes, Jolson, Keaton, Lynagh, McNitt, Neffinger, Nickels, Olson, Thieblot, Widhelm, and Zabriskie.

The degree of Master of Business Administration is conferred on those students who satisfactorily complete the requirements set forth in the section of this catalog entitled "Requirements for the Degree of Master of Business Administration."

The degree of Doctor of Business Administration is conferred on those students who satisfactorily complete the requirements set forth in the section of this catalog entitled "Requirements for the Doctor of Business Administration."

For Graduates and Advanced Undergraduates

BSAD 110, 111. Intermediate Accounting. (3, 3)
Prerequisite, BSAD 021.

BSAD 118, 119. Undergraduate Accounting Seminar. (3) (3)
Prerequisite, senior standing as an accounting major or consent of instructor. Enrollment limited to upper one-third of senior class.

BSAD 120. Accounting Systems. (3)
Prerequisite, BSAD 020.

BSAD 121. Cost Accounting. (3)
Prerequisite, BSAD 021.

BSAD 122. Auditing Theory and Practice. (3)
Prerequisite, BSAD 111.

BSAD 123. Income Tax Accounting. (3)
Prerequisite, BSAD 021.

BSAD 124. Advanced Accounting. (3)
Prerequisite, BSAD 111.

BSAD 125. C.P.A. Problems. (3)
Prerequisite, BSAD 111, or consent of instructor.

BSAD 127. Advanced Auditing Theory and Practice. (3)
Prerequisite, BSAD 122.

BSAD 128. Advanced Cost Accounting. (2)
Prerequisite, BSAD 121.

BSAD 129. Apprenticeship in Accounting. (0)
Prerequisites, minimum of 20 semester hours in accounting and the consent of the accounting staff.

BSAD 130. Business Statistics I. (3)

BSAD 131. Business Statistics II. (3)
Prerequisite, BSAD 130 or equivalent.

BSAD 132. Sample Surveys in Business and Economics. (3)
Prerequisite, BSAD 130 or equivalent.

BSAD 134. Statistical Quality Control. (3)
Prerequisite, BSAD 130 or equivalent.

BSAD 135. Statistical Analysis and Forecasting. (3)
Prerequisite, BSAD 130 or equivalent.

BSAD 136. Operations Research I. (3)
Prerequisite, BSAD 130 or consent of instructor

BSAD 137. Operations Research II. (3)
Prerequisite, BSAD 136 or permission of instructor

BSAD 138. Linear Programming in Business. (3)
Prerequisite, BSAD 136 or permission of instructor

BSAD 140. Business Finance. (3)
Prerequisite, BSAD 021.

BSAD 141. Financial Management. (3)
Prerequisite, BSAD 140.

BSAD 143. Investments. (3)
Prerequisite, BSAD 140.

BSAD 144. Security Analysis and Evaluation. (3)
Prerequisite, BSAD 140.

BSAD 145. Commercial Bank Management. (3)
Prerequisite, BSAD 140.

BSAD 149. Marketing Principles and Organization. (3)
Prerequisite, ECON 032 or 037.

BSAD 150. Marketing Management. (3)
Prerequisite, BSAD 149.

BSAD 151. Advertising. (3)
Prerequisite, BSAD 149.

BSAD 153. Industrial Marketing. (3)
Prerequisite, BSAD 149.

BSAD 154. Retail Management. (3)
Prerequisite, BSAD 020, and 149.

BSAD 155. Consumer Analysis. (3)
Prerequisite, BSAD 150

BSAD 156. Marketing Research Methods. (3)
Prerequisites, BSAD 130 and BSAD 149.

BSAD 157. International Marketing. (3)
Prerequisite, BSAD 149 and BSAD 192.

BSAD 158. Promotion Management. (3)
Prerequisite BSAD 151.

BSAD 160. Personnel Management I. (3)

BSAD 161. Personnel Management II. (3)
Prerequisite, BSAD 160.

BSAD 163. Labor Relations. (3)

BSAD 164. Labor Legislation. (3)

BSAD 165. Advanced Production Management. (3)
Prerequisite, BSAD 169.

BSAD 168. Management and Organization Theory. (3)

BSAD 169. Production Management. (3)

BSAD 170. Principles of Transportation. (3)
Prerequisite, ECON 032 or 037.

BSAD 171. Traffic and Physical Distribution Management. (3)
Prerequisite, junior standing.

BSAD 172. Motor Transportation. (3)
Prerequisite, BSAD 170.

BSAD 173. Water Transportation. (3)
Prerequisite, BSAD 170.

BSAD 174. Commercial Air Transportation. (3)
Prerequisite, BSAD 170.

BSAD 175. Advanced Transportation Problems. (3)
Prerequisite, BSAD 170.

BSAD 176. Urban Transport and Urban Development. (3)
Prerequisite, ECON 032 or 037.

BSAD 180. Business Law. (3)

BSAD 181. Business Law. (3)

BSAD 182. Legal Environment of Business. (3)

BSAD 184. Public Utilities. (3)
Prerequisites, ECON 032 or 037.

BSAD 189. Business and Government. (3)
Prerequisites, ECON 032 or 037.

BSAD 190. Risk Management. (3)

BSAD 191. Principles of Risk and Insurance. (3)

BSAD 192. Introduction to International Business Management. (3)

BSAD 195. Real Estate Principles. (3)
Prerequisite, ECON 032 or 037.

BSAD 196. Urban Land Management. (3)

BSAD 198. Structure and Operations of Industries. (3)

BSAD 199. Business Policies. (3)

For Graduates

BSAD 210. 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 211. Advanced Accounting Theory II. (3)
Prerequisite BSAD 210. 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 212. 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 213. 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 deferment.

BSAD 214. Current Problems of Professional Practice. (3)
A study of the current problems of the C.P.A. in the practice of the professional accountant: Generally accepted auditing standards, auditing practices, legal and ethical responsibilities, and the accounting and reporting requirements of the Securities and Exchange Commission.

BSAD 220. 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 220 or 240 is required of M.B.A. candidates.

BSAD 221. Managerial Accounting II. (3)
Prerequisite BSAD 220. 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 230. Statistical Analysis and Business Decisions. (3)
This course acquaints students with the "Bayesian" approach to decision-making. Topics dealt with 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 231. Theory of Survey Design. (3)
A course examining the usefulness of statistical principles in survey design. The discussion covers such topics as the nature of statistical estimation, the differential attributes of different estimators, the merits and weaknesses of available sampling methods and designs. Detailed attention is given to the distinctive aspects of simple random samples, stratified random samples, and cluster samples. Some time is spent on a consideration of ratio estimates and the problems posed by biases and non-sampling errors.

BSAD 234. Managerial Analysis I. (3) Required for M.B.A. candidates.
The processes, tools, and evaluation of quantitative analysis for management. Emphasizes 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. Where feasible the computer's role in management analysis will be emphasized and demonstrated.

BSAD 235. Management Science—Deterministic Models. (3)
Prerequisite, Mathematics, through differential calculus, and BSAD 234 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 236. Management Science—Probabilistic Models. (3)
Prerequisite. Consent of instructor. The theory and use of probabilistic models in management science. Models are based upon conditions of data uncertainty. Include queuing models , network models, game theoretic models involving Markov processes.

BSAD 237. Management Simulation. (3)
Prerequisite, BSAD 234 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 238. Optimization Methods for Managerial Analysis. (3)
Prerequisite, a course dealing with the theory and application of linear programming such as BSAD 235, ECON 214, or permission of instructor. The theory and use of optimization methods for managerial analysis. Review of simplex algorithm. Covers transportation algorithms, dynamic programming and where feasible quadratic programming, parametric programming and other appropriate optimization techniques.

BSAD 240. 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 220 or 240 is required of M.B.A. candidates.

BSAD 241. 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 fund requirements, patterns of fund requirements, and major types of loan arrangements. Case studies, supplemented with outside readings.

BSAD 242. 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 243. 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 244. Portfolio Management. (3)
Prerequisite. BSAD 243 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 245. 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 247. 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. Also includes consideration

of national and international financial institutions as they relate to the international operations of American and foreign business firms.

BSAD 250. Marketing Administration. (3)
Required for M.B.A. candidates with concentrations in Marketing. Principal objectives of the course 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 251. Marketing Communications Management. (3)
Required for M.B.A. candidates concentrating in Marketing. This course is 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 252. Marketing Research Methods. (3)
Required for M.B.A. candidates concentrating in Marketing. The course 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 254. Marketing Channels Analysis. (3)
A course that focuses on the fundamentals explaining alternate channels of distribution and the roles played by various intermediaries, the evolution of business structures in marketing, reasons for change, and projected marketing patterns for the future. M.B.A. candidates may register with permission of instructor.

BSAD 256. 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 257. Theory in Marketing. (3)
An inquiry into the problems and elements of theory development in general with specific references 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 258. 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 260. 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 261. Collective Bargaining—Current Problems and Issues. (3)
Examines contemporary problems and issues associated with collective bargaining. 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 262. 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 263. 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 264. Behavioral Factors in Management. (3)
Required of M.B.A. candidates.
A critical analysis of the impact of the behavioral sciences on traditional concepts of management as process and as organization. Included within the area of analysis are such subjects as human motivation, human relations, morale, status, role, organization, communication, bureaucracy, the executive role, leadership and training.

BSAD 266. 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 267. Personnel Management: Manpower Compensation and Evaluation. (3)
After a work force has been assembled and developed (BSAD 266), 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 269. Application of Behavioral Science to Business. (3)
Prerequisite, BSAD 264 or permission of professor. This course stresses case analysis of behavioral knowledge applied to management problems. Typical topics include analysis of modes for introducing change, group versus organizational goals, organizational barriers to personal growth, the effect of authority systems on behavior, and the relationship between technology and social structure.

BSAD 270. Transportation Theory and Analysis. (3)
This course examines the transportation system and its components. Key topics in the development and present form of transport in both the United States and other

countries are considered together with theoretical concepts employed in the analysis of transport problems.

BSAD 271. 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. Topical 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 272. 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 273. Transportation Strategies. (3)
Treats organization structure, policies, and procedures employed in the administration of inter—and intraurban transport firms. Problems receiving attention include managerial development, operational and financial planning and control, demand analysis, pricing, promotional policies, intra—and intermodal competitive and complementary relationships, and methods for accommodating public policies designed to delimit the managerial discretion of carrier executives. Administrative problems peculiar to publicly-owned and operated transport entities are also considered.

BSAD 274. 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 275. 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 281. Private Enterprise and Public Policy. (3)
Examines the executive's social and ethical responsibilities to his employees, customers, and to the general public. Consideration is given to the conflicts occasioned by competitive relationships in the private sector of business and the effect of institutional restraints. The trends in public policy and their future effect upon management are examined. For comparative purposes, several examples of planned societies are considered.

BSAD 282. 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 283. 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 284. 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 285. 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 287. International Business Administration. (3)
Examines the international business environment as it affects company policy and procedures. Integrates the business functions undertaken in international operations through analysis in depth and comprehensive case studies. This course can be credited toward the 18-hour requirement for a major field in the D.B.A. program.

BSAD 288. Management of the Multinational Firm. (3)
A course dealing 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 289. Development and Trends in Production Management. (3)
Case studies of production problems in a number of industries. The course focuses attention on decisions concerning operating programs and manufacturing policies at the top level of manufacturing. Basic concepts of process and product technology are covered, taking into consideration the scale, operating range, capital cost, method of control, and degree of mechanization at each successive stage in the manufacturing process.

BSAD 298. Independent Study in Business Administration. (1-9)

BSAD 399. Thesis Research. (Master's Level)

BSAD 499. Dissertation Research. (Doctoral Level)

CENTER OF MATERIALS RESEARCH

Director: Ellis R. Lippincott.
Associate Director: Jimmie W. Brasch.
Assistant Director: W. K. Jenne.
Advisory Committee: Drs. Castellan *(ex officio)*, Bhagat, Bolsaitis, Ginter, Gordon, Lippincott, and Marcinkowski.

The Center of Materials Research comprises a faculty interested in experimental and theoretical studies in materials. The Center serves as an ideal place to bring together physicists, chemists and metallurgists to work on problems of mutual interest to the advantage of all. The faculty is made up of members from the Departments of Physics and Astronomy, Chemistry, Chemical Engineering, and Mechanical Engineering, and the Institute of Molecular Physics. Members of the Center teach both undergraduate and graduate courses in the academic departments and supervise thesis research of graduate students.

The major function of the Center is to increase significantly the scientific competence and breadth of its members who will have at their command unique central facilities, laboratory and technical personnel for the development of a truly strong program in materials research.

The following list of examples is not meant to be exhaustive but serves to illustrate the range of the materials program. Studies of interaction of matter with electromagnetic radiation, electronic structure and fundamental interaction in solids, high pressure phenomena, intermolecular interactions, spectra and structure, mechanical properties, thermodynamics and kinetics reactions in materials, electronic and magnetic properties of materials, characterization of materials, neutron scattering and diffraction, metallurgy, and material properties of polymers.

The Center also participates in providing a concentration of studies in materials science in collaboration with these departments. Funds are available for qualified individuals for appointments as research assistant and for postdoctoral fellowships through the various departments.

Courses are offered to graduate students in the Departments of Chemistry, Physics and Astronomy, Chemical Engineering, and Mechanical Engineering, and lead to the degrees of Master of Science and Doctor of Philosophy. Entering students are expected to have an undergraduate degree in chemistry, physics or engineering with a strong background in a closely related second discipline.

Research problems in materials may be supervised by members of the faculty from the Departments of Chemistry, Physics and Astronomy, Chemical Engineering, and Mechanical Engineering, and the Institute for Molecular Physics. Detailed information may be obtained by writing the heads of these departments.

CHEMICAL ENGINEERING

Professors: Beckmann, Duffey,* Gomezplata, Johnson,* Marchello, Schroeder, Silverman,* and Skolnick.**
Associate Professors: Arsenault,** Bolsaitis,** Cadman, Munno,* Regan, Smith, and Spain.**
Assistant Professors: Almenas,* Blair,* Gentry, Raush,* Sheaks,* and Spivak.
Part-Time Professors: Goldman,* Hoffman, and Kruger.
Lecturers: Belcher,* and Dedrick.

The Department directs the programs of graduate students who plan to qualify for the degree of Master of Science or Doctor of Philosophy in the Department of Chemical Engineering. Subject areas of chemical, materials and nuclear engineering, applied polymer science, and bioengineering are offered.

The basic requirements for the degrees of Master of Science and Doctor of Philosophy are set forth on pages 19 and 24 of this catalog. Supplemental regulations for guidance of candidates for these degrees in the Department of Chemical Engineering are available in the Department office.

Chemical Engineering—The program leading to the Master of Science and Doctor of Philosophy degrees is open to qualified students holding the Bachelor of Science degree. In addition to the special areas described below the student may concentrate his study in engineering analysis, transport phenomena, reaction kinetics, and process systems dynamics and control. Required core courses in the major are ENCH 203, 205, 211 and 250. Courses to satisfy the minor may be chosen from chemistry, physics, mathematics, the life sciences, other engineering fields including materials and nuclear engineering, and business administration.

Applied Polymer Science—An interdisciplinary special area in polymer science is offered leading to the Master of Science and Doctor of Philosophy degrees. The program is open to qualified students holding Bachelor of Science degrees in engineering, physics and chemistry. Courses to satisfy the major requirements may be selected from those offered within the Departments of Chemical Engineering, Mechanical Engineering, Chemistry, and Physics. The student must also fulfill the core course requirements of either the chemical, nuclear or materials engineering programs while specializing in the polymers field. Courses to satisfy the minor requirements may be chosen from related courses in engineering, mathematics and the sciences.

Biological and Environmental Health Engineering—This special area is offered as part of a joint effort with other engineering and interdisciplinary groups throughout the University. The program leading to the Master of Science and Doctor of Philosophy degrees is open to qualified students holding the Bachelor of Science degree. Courses to satisfy the major requirements may be chosen from those offered in biological and environmental engineering and selected courses in the life and chemical sciences. The student must also fulfill the core course requirements of the chemical engineering program while specializing in the biological and environmental field. Courses to satisfy the minor may be chosen from the biological or medical sciences, chemistry, physics, mathematics, or other engineering fields.

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*Member of Nuclear Engineering Program.
**Member of Engineering Materials Program.

THERMODYNAMICS AND ANALYSIS

For Graduates and Advanced Undergraduates

ENCH 109. Chemical Process Thermodynamics. (3)
First semester. Prerequisite, ENCH 050. Estimation of thermodynamic properties of pure substances and mixtures. Chemical and phase equilibria in ideal and non-ideal systems. Thermodynamic analysis of processes, equilibrium stage operations, thermodynamics of chemically reacting systems. (Marchello)

ENCH 116. Applied Mathematics in Chemical Engineering. (3)
Second semester. Prerequisite, MATH 021 and ENCH 127. Mathematical technique 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. (Gentry)

ENCH 152. Advanced Chemical Engineering Analysis. (3)
Second semester. Prerequisite, ENCH 109. Application of digital and analog computers to chemical engineering problems. Numerical methods, programming, differential equations, curve fitting, amplifiers and analog circuits. (Cadman)

ENCH 154. Chemical Process Analysis. (3)
First semester. Prerequisite, ENCH 129, 145. Applications of mathematical models of chemical processes based on transport phenomena, chemical kinetics and other chemical engineering methods. Emphasis on principles and results of modelling.

For Graduates

ENCH 203. 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. (Spain)

ENCH 209. Complex Equilibrium Stage Processes. (3)
Second semester. The theory and application of complex equilibrium stages. Binary and multicomponent distillation; multicomponent absorption; extraction; liquefaction. (Staff)

ENCH 250. 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 253. Advanced Topics in Thermodynamics. (3)
Second semester. Prerequisite, CHEM 203. (Staff)

TRANSPORT AND TRANSFER PHENOMENA

For Graduates and Advanced Undergraduates

ENCH 127. Transfer and Transport Processes I. (4)
Prerequisite, ENCH 50. 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 129. Transfer and Transport Processes II. (3)
Prerequisite, ENCH 127. Steady and unsteady state diffusion and conduction, simultaneous heat and mass transfer, interphase transfer, boundary layer theory. Application to absorption, adsorption, extraction and distillation. Principles of radiant heat transfer, evaporation, filtration, crystallization, drying, condensation, boiling, humidification, ion exchange, and phase separations.

ENCH 137. Chemical Engineering Laboratory. (3)
First and second semester. Prerequisite, ENCH 129. 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.
(Cadman, Regan)

For Graduates

ENCH 205. 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. (Gentry, Marchello)

ENCH 207. Process Analysis and Simulation. (3)
Second Semester. Prerequisite, ENCH 205. 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 computers methods.

ENCH 257. Advanced Topics in Transfer Theory. (3)
First semester. Offered in alternate years. Prerequisite, ENCH 207. (Staff)

ENCH 259. Advanced Topics in Separation Processes. (3)
Second semester. *Offered in alternate years.* (Marchello)

CHEMICAL REACTION KINETICS

For Graduates and Advanced Undergraduates

ENCH 145. Chemical Engineering Kinetics. (3)
First semester. Prerequisite, ENCH 050. Fundamentals of chemical reaction kinetics and their application to the design and operation of chemical reactions. Reaction rate theory, homogeneous reactions in batch and flow systems, adsorption, heterogeneous reactions and catalysis, electrochemical reactions. Catalytic reactor design. (Cadman)

For Graduates

ENCH 211. 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. (Beckmann, Marchello)

ENCH 255. Advanced Topics in Chemical Reaction Systems. (3)
First semester. *Offered in alternate years.* Prerequisite, ENCH 211. (Gomezplata)

PROCESS SYSTEMS DYNAMICS AND DESIGN

For Graduates and Advanced Undergraduates

ENCH 147. Process Engineering and Design. (3)
Second or first semester. Prerequisite, ENCH 129. Utilization of chemical engineering principles for the design of process equipment. Typical problems in the design of chemical plants. Comprehensive reports are required. (Schroeder)

ENCH 149. Chemical Engineering Economics. (2)
Second semester. Prerequisite, ENCH 129. Principles of engineering economy applied to chemical processes. Optimizing methods in the design and operation of industrial processes. Determination of investment and operating costs for chemical plants. (Schroeder)

ENCH 150. Chemical Process Development. (3)
First semester. Prerequisite, ENCH 129. Chemical process industries from the standpoint of technology, raw materials, products and processing equipment. Operations of the major chemical processes and industries combined with quantitative analysis of process requirements and yields. (Schroeder)

ENCH 155. Chemical Process Laboratory. (2)
First semester. Prerequisites, ENCH 129, 145, concurrently. Experimental study of the fundamentals of various chemical processes through laboratory and small semi-commercial scale equipment. Reaction kinetics, fluid mechanics, heat and mass transfer. (Regan)

ENCH 157. Chemical Engineering Systems Analysis and Dynamics. (2)
Second semester. Prerequisite, Differential Equations or consent of instructor. Dynamic response applied to process systems. Goals and models of control; LaPlace transformations; representation, analysis and synthesis of simple control systems; closed loop response; dynamic testing; role of modern computing machinery in process control. (Cadman, Smith)

ENCH 159. Dynamics and Control Laboratory. (1)
Second semester. Prerequisite, ENCH 157 concurrently. Methods of process control. Use of experimental and mathematical models of control systems. (Cadman)

For Graduates

ENCH 223. 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. (Schroeder)

ENCH 235. 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. (Cadman, Smith)

ENCH 237. 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. (Cadman)

APPLIED POLYMER SCIENCE

For Advanced Undergraduates and Graduates

ENCH 190. Introduction to Polymer Science. (3)
Prerequisite, consent of instructor. The elements of the chemistry, physics, processing methods, and engineering applications of polymers. (Silverman, Smith)

ENCH 192. Applied Physical Chemistry of Polymers. (3)
Prerequisite, CHEM 187; co-requisite CHEM 189; or consent of instructor. Kinetics of formation of high polymers, determination of molecular weight and structure, and applied thermodynamics and phase equilibria of polymer solutions. (Silverman)

ENCH 198. Polymer Technology Laboratory. (3)
One lecture and two laboratory periods per week. Prerequisite, ENCH 192 or consent of instructor. Laboratory fee $10.00. Measurement of molecular weight by viscosimetry, osmometric and light scattering methods. Application of x-ray, NMR, ESR, spectroscopy, molecular relaxation, microscopy and electron microscopy to the determination of ploymer structure. Effects of ultraviolet light and high energy radiation. (Smith)

For Graduates

ENCH 284. Polymer Physics. (3)
Prerequisite, ENCH 190 or consent of instructor. Application and correlation of mechanical and dielectric relaxation, NMR, electron microscopy, x-ray diffraction, diffusion and electrical properties to the mechanical properties and structure of polymers in the solid state. (Skolnick, Silverman)

ENCH 286. Polymer Processing and Applications. (3)
Prerequisite, ENCH 190 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. (Smith)

ENCH 370. Rheology of Engineering Materials. (3)
Prerequisite, ENCH 350 or ENME 350. 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 390. Polymeric Engineering Materials. (3)
Prerequisite, ENCH 350 or ENME 350 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.

BIOLOGICAL AND ENVIRONMENTAL HEALTH ENGINEERING

For Advanced Undergraduates and Graduates

ENCH 142. Environmental Considerations of Nuclear Engineering. (3)
First semester. Three lectures a week. Prerequisite, permission of instructor. Protection of the public and the environment from the hazards of nuclear energy operations. Handling and disposal of gaseous, liquid and solid radioactive wastes. Meteorological, hydrological and geological phases. Typical problems from mining of ores through nuclear reactor operations and chemical separations. Legislative and economic factors, site selection, plant design and operation as related to the environment.
(Silverman, Munno)

ENCH 161. 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. (Marchello)

ENCH 180. 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. (Regan)

For Graduates

ENCH 261. Engineering Analysis of Circulatory System Transport. (3)
Prerequisite, ENCH 180 or permission of instructor. Flow, transport phenomena, and chemical reactions involved in mammalian circulatory system function. Analysis and interpretation of tracer studies; mathematical models for simulation of transport of drugs and other solutes; internal effects of modifying environmental factors.

ENCH 262. Bioengineering Transport Phenomena. (3)
Prerequisite, ENCH 180 or permission of instructor. Engineering analysis of transport phenomena as they occur in vivo and in prosthetic devices. Survey and critique of current mathematical models for active and passive transport with emphasis on the renal and neural systems.

ENCH 263. Engineering of Artificial Organs. (3)
Prerequisite, ENCH 180 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.

SEMINAR AND RESEARCH

For Undergraduates and Graduates

ENCH 133, 134. Chemical Engineering Seminar. (1, 1)
Prerequisite, senior standing. Oral and written reports on recent developments in chemical engineering and the process industries. Fall and spring semesters. (Staff)

ENCH 165. Research. (2 or 3)
First and second semesters. Prerequisite, permission of the staff. Investigation of a research project under the direction of one of the staff members. Comprehensive reports are required. (Staff)

For Graduates

ENCH 201. Graduate Seminar. (1)
(Staff)

ENCH 247. Special Problems in Chemical Engineering.

ENCH 399. Thesis Research. (Master's Level)

ENCH 499. Dissertation Research. (Doctoral Level)

ENGINEERING MATERIALS

Professors: Armstrong,* Asimow,* Marcinkowski,* and Skolnick.**
Associate Professors: Arsenault,** Bolsaitis,** and Spain.**

This program is given jointly by the Department of Chemical Engineering and the Department of Mechanical Engineering and offers courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The program is open to qualified students holding bachelor degrees in engineering, the physical sciences and mathematics.

Courses to satisfy the major requirements in Engineering Materials must be selected from those designated as materials engineering by the Chemical and Mechanical Engineering Departments. Courses to satisfy the minor may be chosen from the Department of Chemistry, Physics, Mathematics, or other engineering courses including chemical and mechanical engineering.

For Advanced Undergraduates and Graduates

ENMA 162. Deformation of Engineering Materials. (3)
Prerequisites, ES 30 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 163. Chemical, Liquid and Powder Processing of Engineering Materials.
Prerequisites, ENES 030 or consent of instructor. Methods and processes used in the production of primary metals. 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 164. Environmental Effects on Engineering Materials.
Prerequisites, ENES 030 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 170. 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. (Skolnick)

ENMA 171. Physical Chemistry of Engineering Materials. (3)
Equilibrium multicomponent systems and relationship to the phase diagram. Thermodynamics of polycrystalline and polyphase materials. Diffusion in solids, kinetics of reactions in solids. (Bolsaitis)

ENMA 172. 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

*Member of Mechanical Engineering Department
**Member of Chemical Engineering Department

emphasis on the relationships between structure of the solid and its potential engineering application. (Staff)

ENMA 173. 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. (Staff)

For Graduates

ENMA 350. Structure of Engineering Materials. (3)
The structural aspects of crystalline and amorphous solids and relationship 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. (Skolnick)

ENMA 351. Electronic Structure of Engineering Solids. (3)
Prerequisite: ENCH 350 or ENME 350. Description of electronic behavior in engineering solids. Behavior of conductors, semiconductors and insulators in electrical fields. Thermal, magnetic and optional properties of engineering solids. (Spain)

ENMA 359. Special Topics in Structure of Engineering Materials. (3)
Prerequisite, consent of instructor.

ENMA 360. Chemical Physics of Engineering Materials. (3)
Prerequisite, ENCH 350 or ENME 350. 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. (Bolsaitis)

ENMA 361. Kinetics of Reactions in Materials. (3)
Prerequisite, ENCH 360 or ENME 360. The theory of thermally activated processes in solids as applied to diffusion, nucleation and interface motion. Cooperative and diffusionless transformations. Applications selected from processes such as allotropic transformations, precipitation, martensite formation, solidification, ordering, and corrosion. (Staff)

ENMA 369. Special Topics in the Chemical Physics of Materials. (3)
Prerequisite, consent of instructor.

ENMA 370. Rheology of Engineering Materials. (3)
Prerequisite, ENCH 350 or ENME 350. 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. (Smith)

ENMA 371. Dislocations in Crystalline Materials. (3)
Prerequisite, ENCH 350 or ENME 350. 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. (Arsenault)

ENMA 372. Mechanical Properties of Engineering Materials. (3)
Prerequisite, ENCH 370 or ENME 370. 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. (Arsenault)

ENMA 379. Special Topics in the Mechanical Behavior of Engineering. Solids. (3)
Prerequisite, consent of instructor. (Staff)

ENMA 380. 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. (Staff)

ENMA 381. Diffraction Techniques in Materials Science. (3)
Prerequisite, ENCH 350 or ENME 350. 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. (Skolnick)

ENMA 389. Special Topics in Experimental Techniques in Materials Science. (3)
Prerequisite, consent of instructor. (Staff)

ENMA 390. Polymeric Engineering Materials. (3)
Prerequisite, ENCH 350 or ENME 350 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. (Smith)

ENMA 391. Special Topics in Materials Technology. (3)
Prerequisite, consent of instructor. (Staff)

ENMA 397. Seminar in Engineering Materials. (1)
(Staff)

ENMA 398. Special Problems in Engineering Materials.
(Staff)

ENMA 399. Thesis Research. (Master's Level)

ENMA 499. Dissertation Research. (Doctoral Level)

NUCLEAR ENGINEERING

Professors: Duffey, Johnson, and Silverman.
Associate Professor: Munno.
Assistant Professors: Almenas, Blair, Roush, and Sheaks.
Part-Time Professor: Goldman.
Lecturer: Belcher.

This program is offered by the Department of Chemical Engineering and represents courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The program is open to qualified students holding bachelor degrees in engineering, the physical sciences and mathematics. Courses to satisfy the major requirements in Nuclear Engineering must be selected from those designated as nuclear engineering by the Chemical Engineering Department. Courses to satisfy the minor may be chosen from the Departments of Chemistry, Physics, Mathematics, or other engineering courses including chemical engineering.

For Advanced Undergraduates and Graduates

ENNU 100. Introductory to Nuclear Technology. (3)
Prerequisites, MATH 021 and PHYS 032. Engineering problems of the nuclear energy complex, including basic theory, nuclear reactor design, and isotopic and chemical separations.

ENNU 101. Environmental Aspects of Nuclear Energy. (3)
Protection of the public and the environment from the hazards of nuclear operations. Radiation monitoring, handling and disposal of radioactive wastes. Site selection, plant design and operation as related to the environment.

ENNU 102. Nuclear Reactor Operation. (3)
Introduction to nuclear reactor operations. Outline of reactor theory. Nature and monitoring techniques of ionizing radiation, radiation safety. Reactor instrument response. Operation of the University of Maryland nuclear reactor.

ENNU 103. Radioisotope Power Sources. (3)
Prerequisite, ENNU 100 or permission of instructor. Principles and theory of radioisotope power sources. Design and use of nuclear batteries and small energy conversion devices.

ENNU 148. Nuclear Technology Laboratory. (2 to 4)
One or two lectures, and one or two laboratory periods a week. Prerequisites, CHEM 003, PHYS 021, MATH 021, ENCH 140, or equivalents, and permission of instructor. Techniques of detecting and making measurements of nuclear or high energy radiation. Radiation safety experiments. Both a sub-critical reactor and the 10-KW swimming pool critical reactor are sources of radiation. (Silverman, Munno)

ENNU 163. Nuclear Reactor Engineering I. (3)
Prerequisites, MATH 066 and Physics 032 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 165. Research. (2 or 3)

ENNU 167. Nuclear Reactor Engineering II. (3)
Prerequisite, ENNU 163. 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 169. Reactor Core Design. (3)
Prerequisites, ENNU 163 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.

For Graduates

ENNU 250. 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.

ENNU 301. Seminar in Nuclear Engineering. (1)
(Staff)

ENNU 308, 309. Nuclear Reactor Laboratory. (3, 3)
Two lectures and two laboratory periods a week. Prerequisites, permission of instructor, ENCH 148, 302, 303, 305, or equivalent. The University of Maryland 10-KW swimming pool reactor is employed in experiments on reactor startup and operation, shielding, control, neutron flux distributions, neutron and gamma spectrum, cross section measurements. (Staff)

ENNU 311. Nuclear Fuel and Waste Processing. (3)
First semester. Three lectures a week. Processing of nuclear fuel and treatment of nuclear waste. Includes: (1) processing of uranium, thorium, and other ores; (2) chemical separation of plutonium, uranium, fission products and other elements from materials irradiated in nuclear reactors; (3) treatment of radioactive wastes; (4) isotopic separation of U235; and (5) isotopic separation of heavy water and other materials. (Silverman)

ENNU 313. Selected Topics in Nuclear Engineering. (3)
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.
(Staff)

ENNU 314. Special Problems in Nuclear Engineering.

ENNU 315, 316. Radiation Engineering. (3, 3)
Second semester. Two lectures a week. 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.
(Silverman)

ENNU 317. 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. (Silverman)

ENNU 320. Nuclear Reactor Physics I. (3)
First semester. 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 will be developed together with approximations such as Pn, Sn, and Fermi Age. Nuclear systems will be theoretically treated utilizing the diffusion approximation, the Fermi Age method and the P-3 method. Elementary temperature and time dependence. (Munno)

ENNU 321. Nuclear Reactor Physics II. (3)
Second semester. Prerequisite: ENCH 320. Mathematical treatment of nuclear reactor systems. To be presented in this course are 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. (Munno)

ENNU 331. Neutral Particle Transport Theory. (3)
First semester. Prerequisite: ENCH 320 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.
(Munno)

ENNU 333. Radiation Shielding and Energy Deposition. (3)
First semester. Prerequisite: ENCH 320 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. (Goldman)

ENNU 335. Nuclear Reactor Design. (3)
Prerequisites: ENNU 320 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 utilizied throughout.

ENNU 337. Nuclear Reactor Dynamics. (3)
Second semester. Prerequisites; ENCH 321. 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. (Staff)

ENNU 340. Fast Reactor Engineering. (3)
Prerequisites, ENNU 321. 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 399. Thesis Research. (Master's Level)

ENNU 499. Dissertation Research. (Doctoral Level)

CHEMISTRY

Professor and Head: Vanderslice.
Professor and Associate Head: Jaquith.
Professors: Atkinson, Benedict,* Benesch, Breger *(Visiting),* Castellan, Grim, Henery-Logan, Keeney, Lippincott, Pratt, Purdy, Reeve, Rollinson, Rose *(Visiting),* Stewart, Stuntz, Svirbely, Veitch, and White.
Research Professors: Bailey, and Zwanzig.*
Associate Professors: Boyd, DeRocco,* DeVoe, Freeman *(Visiting),* Ginter,* Gordon, Holmlund, Huheey, Kasler, Krisher,* Lakshmanan, Munn,* Pickard, Riemann *(Visiting),* Sengers,* Staley, Tilford *(Visiting),* Viola, and Waltes.
Assistant Professors: Ammon, Barker, Bellama, Campagnoni, Davis, Hanson, Helz, Jackson, Jarvis, Khanna, Martin, Mazzocchi, Miller, Moore, Murphy, O'Haver, Olin, Sampugna, Sommer, Wineshenker, and Zoller.

The Chemistry Department offers programs leading to the Master of Science or Doctor of Philosophy degrees in analytical chemisty, biochemistry, inorganic chemistry, organic chemistry, physical chemistry, and chemical physics. For the latter program, the Chemistry Department cooperates with the Institute for Molecular Physics and the Department of Physics and Astronomy in both Master of Science and Doctor of Philosophy programs.

Departmental regulations concerning qualifying and 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.

*Members of the Institute for Molecular Physics.

ANALYTICAL CHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 121. Intermediate Quantitative Analysis. (4)
Two lectures and two three-hour laboratory periods per week. Prerequisites, CHEM 019 or 021, and CHEM 033 or 037. A continuation of CHEM 019 or 021, including volumetric, gravimetric, electrometric, and colorimetric methods. Intended for students in agricultural chemistry, general physical science, science education, etc. Not open to chemistry majors. (Stuntz)

CHEM 123. Advanced Quantitative Analysis. (3)
Two lectures and one three-hour laboratory period per week. Prerequisite, CHEM 189 or concurrent registration therein. A continuation of CHEM 021, including volumetric, gravimetric, electrometric, and colorimetric methods. Required of all students majoring in chemistry. (Purdy)

CHEM 125. Instrumental Analysis. (4)
Second semester. Two lectures and six hours of laboratory per week. Prerequisite, CHEM 189. A study of the application of physicochemical methods to analytical chemistry. Techniques such as polarography, potentiometry, conductivity and spectrophotometry will be included. (Purdy)

CHEM 150. Organic Quantitative Analysis. (2)
Two three-hour laboratory periods per week. Prerequisites, CHEM 019 or 021, and consent of the instructor. The semi-micro determination of carbon, hydrogen, nitrogen, halogen and certain functional groups. (Kasler)

For Graduates

CHEM 206, 208. Spectrographic Analysis. (1, 1)
One three-hour laboratory period per week. Registration limited. Prerequisites, CHEM 184 and consent of the instructor. (White)

CHEM 221, 223. Chemical Microscopy. (2, 2)
One lecture and one three-hour laboratory period per week. Registration limited. Prerequisite, consent of instructor. CHEM 221 is a prerequisite for CHEM 223. A study of the use of the microscope in chemistry. CHEM 223 is devoted to study of the optical properties of crystals. (Stuntz)

CHEM 227. Optical Methods of Quantitative Analysis. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, CHEM 123 and 189. The quantitative applications of emission spectroscopy, atomic absorption spectroscopy, ultraviolet, visible, and infrared spectrophotometry, fluorescence, atomic fluorescence, nephelometry, and of certain closely related subjects like NMR and mass spectroscopy. (Staff)

CHEM 229. Electrical Methods of Quantitative Analysis. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, CHEM 123 and 189. The use of conductivity, potentiometry, polarography, voltammetry, amperometry, coulometry, and chronopotentiometry in quantitative analysis. (Purdy)

CHEM 231. Separation Methods in Quantitative Analysis. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, CHEM 123 and 189. The theory and practical application to quantitative analysis of the various forms of chromatography, ion exchange, solvent extraction, and distillation. (Staff)

CHEM 233. Modern Trends in Analytical Chemistry. (2)
Two lectures per week. Prerequisites, CHEM 123 and 189. 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. (Stoff)

BIOCHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 161. Chemical Background for Biochemistry. (2)
Two lectures per week. Prerequisite, CHEM 033 or CHEM 037. Organic and physical chemical properties of biologically important compounds and systems. (Holmlund)

CHEM 163. Biochemistry. (3)
Three lectures per week. Prerequisite, CHEM 161. (Holmlund)

CHEM 162, 164. Biochemistry Laboratory. (2, 2)
Two three-hour laboratory periods per week. Prerequisite, CHEM 033, CHEM 038 or CHEM 042; CHEM 161 or CHEM 163 (or concurrent registration in CHEM 161, CHEM 163). (Lakshmanan)

For Graduates

CHEM 261. Proteins, Amino Acids, and Carbohydrates. (2)
Two lectures per week. Prerequisite, CHEM 163 or equivalent. (Veitch)

CHEM 263. Biological Energy Transductions, Vitamins, and Hormones. (2)
Two lectures per week. Prerequisite, CHEM 163 or equivalent. (Veitch)

CHEM 265. Enzymes. (2)
Two lectures per week. Prerequisite, CHEM 163 or its equivalent. (Veitch)

CHEM 267. The Chemistry of Natural Products. (2)
Two lectures per week. Prerequisite, CHEM 143. The chemistry and physiological action of natural products. Methods of isolation, determination of structure, and synthesis. (Henery-Logan)

CHEM 268. Special Problems in Biochemistry. (2-4)
Two to four three-hour laboratory periods per week. Prerequisite, CHEM 164 or its equivalent. (Staff)

CHEM 269. Advanced Radiochemistry. (2)
Two lectures per week. Prerequisite, CHEM 205 and CHEM 163. Utilization of radioisotopes with special emphasis on applications to problems in the life sciences. (Lakshmanan)

CHEM 270. Advanced Radiochemistry Laboratory. (1-2)
One or two four-hour laboratory periods per week. Prerequisite, CHEM 210 and consent of instructor. Registration limited. Laboratory training in the utilization of radioisotopes with special emphasis on applications to problems in the life sciences. (Lakshmanan)

CHEM 271. Biochemistry of Lipids. (2)
Two lectures per week. Prerequisite, CHEM 163 or its equivalent. Classification and chemistry of lipids, lipogenesis and energy metabolism of lipids, structural lipids, and endocrine control of lipid metabolism in mammals. (Staff)

CHEM 273. Special Topics in Biochemistry. (2)
Two lectures per week. Prerequisite, CHEM 163 or its equivalent. An examination of some current topics in modern biochemistry. (Staff)

CHEM 275. Biophysical Chemistry. (2)
Two lectures per week. Prerequisite, CHEM 161; CHEM 189, or consent of instructor. (Staff)

INORGANIC CHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 101. Inorganic Chemistry. (3)
Three lectures per week. Prerequisite, CHEM 187. (Staff)

CHEM 102. Inorganic Preparations. (2)
Two three-hour laboratory periods per week. Prerequisite, CHEM 123. (Boyd)

CHEM 110. Radiochemical Safety Procedures. (1)
One lecture per week. A lecture and demonstration course. Radiation hazards, principles and practices of radiation safety, federal (AEC, ICC) codes and state public health laws, etc., will be discussed. Consent of the instructor must be obtained. (Lakshmanan)

For Graduates

CHEM 201. Advanced Inorganic Chemistry. (2)
First semester. Two lectures per week. (Staff)

CHEM 202, 204. Advanced Inorganic Laboratory. (2, 2)
Two three-hour laboratory periods per week. (Boyd)

CHEM 203. The Chemistry of the Rarer Elements. (2)
Second semester. Two lectures per week. (Boyd)

CHEM 205. Radiochemistry. (2)
Two lectures per week. (Viola)

CHEM 207. Chemistry of Coordination Compounds. (2)
Two lectures per week. (Rollinson)

CHEM 209. Non-Aqueous Inorganic Solvents. (2)
Two lectures per week. (Jaquith)

CHEM 210. Radiochemistry Laboratory. (1-2)
One or two four-hour laboratory periods per week. Registration limited. Prerequisites, CHEM 205 (or concurrent registration therein), and consent of instructor. (Lakshmanan)

CHEM 211. Chemistry of Organometallic Compounds. (2)
Two lectures per week. (Grim)

CHEM 213. Selected Topics in Inorganic Chemistry. (2)
Two lectures a week. Prerequisite, CHEM 201, 203 or equivalent. An examination of some current topics in modern inorganic chemistry. (Staff)

CHEM 215. Nuclear Chemistry (2)
Two lecture hours per week Prerequisite, CHEM 189. 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. (Staff)

ORGANIC CHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 141, 143. Advanced Organic Chemistry. (2)
Two lectures per week. Prerequisites, CHEM 037, 038. An advanced study of the compounds of carbon. (Reeve)

CHEM 144. Advanced Organic Laboratory. (2-4)
Two or four three-hour laboratory periods per week. Prerequisites, CHEM 037, 038. (Pratt)

CHEM 148. The Identification of Organic Compounds. (3)
Two three-hour laboratory periods per week. Prerequisite, CHEM 141. The systematic identification of organic compounds. (Pratt)

For Graduates

(One or more courses from the following group 240-254 will customarily be offered each semester.)

CHEM 237. Organic Reaction Mechanisms. (3)
Three lectures per week. (Staff)

CHEM 239. Physical Organic Chemistry. (3)
Three lectures per week. (Staff)

CHEM 240. 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. (Bailey)

CHEM 243. 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 143 and CHEM 189. (Staley)

CHEM 245. The Chemistry of the Steroids. (2)
Two lectures per week. (Pratt)

CHEM 251. The Heterocyclics. (2)
Two lectures per week. (Pratt)

CHEM 253. Special Topics in Organic Chemistry. (2)
Two lectures per week. (Staff)

CHEM 258. The Identification of Organic Compounds, An Advanced Course. (3)
One lecture and two to four three-hour laboratory periods per week. Prerequisite, CHEM 141, 143 or concurrent registration therein. (Pratt)

PHYSICAL CHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 182, 184. Physical Chemistry Laboratory for Chemistry Majors. (1, 1)
One three-hour laboratory period per week. Prerequisite, CHEM 019 or 021; CHEM 187, 189 must be taken concurrently. (Staff)

CHEM 186. Advanced Physical Chemistry Laboratory. (2)
Two three-hour laboratory periods per week. Prerequisites, CHEM 184, CHEM 189. (Staff)

CHEM 187, 189. Physical Chemistry. (3, 3)
Three lectures per week. Prerequisite, CHEM 019 or 021; PHYS 032; MATH 021; or consent of instructor. A course primarily for chemists and chemical engineers. This course must be accompanied by CHEM 182, 184 or CHEM 188, 190. (Staff)

CHEM 188, 190. Physical Chemistry Laboratory. (2, 2)
Two three-hour laboratory periods per week. A laboratory course for chemical engineering students taking CHEM 187, 189. Students who have had CHEM 019, 021, or equivalent, cannot register for this course. (Staff)

CHEM 195. Advanced Physical Chemistry. (2)
Prerequisite, CHEM 189. Quantum chemistry and other selected topics. (Staff)

CHEM 196. 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 or supporting area requirements for chemistry majors.

For Graduates

The common prerequisites for the following courses are CHEM 187 and 189. One or more courses of the group, 287-323, will be offered each semester depending on demand.

CHEM 287. Infra-Red and Raman Spectroscopy. (2)
Two lectures per week. Prerequisite, consent of instructor. (Lippincott)

CHEM 291. Selected Topics in Physical Chemistry. (2)
Two lectures per week. (Staff)

CHEM 293. Special Topics in Physical Chemistry. (3)
Three lectures per week. (Staff)

CHEM 299. Reaction Kinetics. (3)
Three lectures per week. (Svirbely)

CHEM 303. Electrochemistry. (3)
Prerequisite, CHEM 307 or equivalent. Three lectures per week. (Atkinson)

CHEM 304. Electrochemistry Laboratory. (2)
Two three-hour laboratory periods per week. Prerequisite, consent of instructor. (Svirbely)

CHEM 307. Chemical Thermodynamics. (3)
Prerequisite, CHEM 189 or equivalent. Three lectures per week. (Staff)

CHEM 311. Physicochemical Calculations. (2)
Prerequisite, CHEM 189 or equivalent Two lectures per week. (Stewart)

CHEM 313. Molecular Structure. (3)
Three lectures per week. (Staff)

CHEM 317. Chemical Crystallography. (3)
Three lectures per week. Prerequisite, consent of instructor. A detailed treatment of single-crystal X-ray methods. (Stewart)

CHEM 319, 321. Quantum Chemistry. (3, 3)
Three lectures per week. Prerequisite for CHEM 319 is CHEM 195. Prerequisite for CHEM 321 is CHEM 319 or PHYS 212. (Staff)

CHEM 323. Statistical Mechanics and Chemistry. (3)
Three lectures per week. Prerequisite, CHEM 307 or equivalent. (Staff)

SEMINAR AND RESEARCH

CHEM. 351. Seminar. (1)
First and second semesters. (Staff)

CHEM 399. Thesis Research. (Master's Level)
First and second semesters, summer session. (Staff)

CHEM 499. Dissertation Research. (Doctoral Level)
(Staff)

CIVIL ENGINEERING

Professors: Looney, Lepper, Otts, and Ragan.
Associate Professors: Birkner, Carter, Cookson, Cournyn, Garber, Gohr, Heins, Israel, Kondner, Piper, Sternberg, and Wedding.
Assistant Professors: Colville, Hall, Reilly, Scranton, and Witczak *(Visiting).*
Lecturers: Byington and Rajan.

The Department of Civil Engineering offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Courses and research opportunities are available in the general areas of transportation and urban systems, environmental and water resources, and structural engineering. All programs are planned on an individual basis to consider the student's background and his special interests. Emphasis is on the use of sound engineering methodology for the solution of the physical problems of man's environment.

TRANSPORTATION AND URBAN SYSTEMS ENGINEERING

For Graduates and Advanced Undergraduates

ENCE 100. Engineering Analysis and Computer Programming. (3)
Three lectures each week. Prerequisite, ENCE 112 or concurrent registration. (Garber)

ENCE 104. Computer Analysis. (3)
Two lectures and one laboratory each week. Prerequisites, ENCE 100 and ENCE 102. (Garber)

ENCE 108. Fundamentals of Transportation Engineering. (3)
Prerequisite, ENCE 050 and ENCE 090. (Byington, Wedding)

ENCE 109. Basic Civic Engineering Planning I. (2)
Two lectures each week. Prerequisites, ENCE 103, 106, 107 and 108. (Piper)

ENCE 110. Basic Civil Engineering Planning II. (1)
One laboratory of three hours each week. Prerequisite, ENCE 109. (Piper)

ENCE 112. Applied Mathematics in Engineering. (3)
Three lectures each week. Prerequisite, MATH 022. (Staff)

ENCE 185. Highway Engineering. (3)
Three lectures each week. Prerequisite, ENCE 107. (Wedding)

ENCE 186. Transportation Engineering. (3)
Three lectures each week. Prerequisite, ENCE 108. (Wedding)

ENCE 187. Analysis of Civil Engineering Systems I. (3)
Three lectures each week. Prerequisite, ENCE 100 or consent of instructor. (Staff)

ENCE 188. Analysis of Civil Engineering Systems II. (3)
Three lectures each week. Prerequisite, ENCE 187 or consent of instructor. (Staff)

For Graduates

ENCE 261. Urban-Regional Civil Engineering Planning. (3)
Prerequisite, degree in Civil Engineering or consent of instructor. Theory and methodology for the synthesis of general civil engineering aspects of urban and regional planning. Integration of land use conditions and capabilities, population factors and needs, engineering economics and engineering technologies. Application to special problems in urban-regional development. Preparation of engineering reports. Presentation methods. (Piper)

ENCE 262. Civil Engineering Planning. (3)
Prerequisite, ENCE 261 or equivalent. General to comprehensive planning of complex engineering facilities such as industrial plants, bridges, utilities and transportation projects. Planning based on the synthesis of all applicable factors. Emphasis on general civil engineering planning including site, structural and construction planning. Plan evaluation and feasibility. (Piper)

ENCE 281. Highway Traffic Characteristics and Measurements. (3)
Prerequisite, ENCE 185 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. (Staff)

ENCE 282. Highway Traffic Operations. (3)
Prerequisite: ENCE 185, ENCE 281 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. (Staff)

ENCE 283. Transportation Planning I. (3)
Prerequisite, ENCE 186 or consent of instructor. A review of the transportation problem as it relates to the development patterns in American cities. The theory and application of socio-economic factors directed towards the formulation of models for conducting transportation studies. (Staff)

ENCE 284. Transportation Planning II. (3)
Prerequisite, ENCE 283 or consent of instructor. The theory and application of transportation planning models Traffic distribution models including growth factor methods, gravity, intervening opportunity interactance, electrostatic, and probability models. Traffic assignment models and modal split analyses. (Staff)

ENCE 285. Rail Transportation Engineering. (3)
Prerequisite, ENCE 186 or consent of instructor. A study of the basic engineering components of conventional railroads, high speed railroads, and urban rail 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. (Staff)

ENCE 286. Airport Planning and Design. (3)
Prerequisite, ENCE 186 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. (Staff)

ENCE 287. Highway Traffic Flow Theory. (3)
Prerequisite, ENCE 187, ENCE 188 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. (Staff)

ENVIRONMENTAL AND WATER RESOURCES ENGINEERING

For Graduates and Advanced Undergraduates

ENCE 105. Basic Fluid Mechanics. (3)
First semester. Three lectures each week. Prerequisite, ENES 020, 021, PHYS 031. Prerequisite, ENME 105, or concurrent registration. (Cournyn)

ENCE 106. Fundamentals of Sanitary Engineering. (3)
Three lectures each week. Prerequisite, ENCE 105. (Otts, Cookson)

ENCE 145. Advanced Fluid Mechanics. (4)
Three lectures and one laboratory each week. Prerequisite, ENCE 105. (Sternberg)

ENCE 146. Hydrologic Analysis and Design. (3)
Prerequisites, ENCE 100, ENCE 105; Concurrent registration in ENCE 104 or permission of instructor. (Ragan)

ENCE 147. Ground Water Hydrology. (3)
Prerequisites, ENCE 104, ENCE 105, or permission of instructor. (Sternberg)

ENCE 175. Sanitary Engineering Analysis and Design. (4)
Three lectures and one laboratory each week. (Otts, Cookson)

ENCE 176. Environmental Health Engineering Analysis. (3)
Two lectures and one laboratory each week. (Birkner)

ENCE 177. 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. (Israel)

For Graduates

ENCE 242. Advanced Hydrologic Analysis. (3)
Prerequisites, ENCE 146, MATH 133, or consent of instructor. Study of physical processes controlling watershed runoff; the use of process simulation and cross-correlation techniques for the analysis of streamflow records; use of stochastic models for the synthesis of critical patterns of low and high streamflows. (Ragan)

ENCE 243. Free Surface Flow. (3)
Prerequisite, ENCE 105 or consent of instructor. Application of fundamentals of fluid mechanics to design problems involving steady and unsteady open channel flow; boundary resistance for uniform and non-uniform conditions; computation of water surface profiles in channels and reservoirs; hydraulic jump; design of flow transition structures; stratified flows. (Ragan)

ENCE 271. Unit Operations of Environmental Health Engineering. (3)
Prerequisite, ENCE 106 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. (Cookson)

ENCE 272. Theory of Aqueous and Solid Waste Treatment and Disposal. (3)
Prerequisites, ENCE 106 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. (Cookson)

ENCE 273. Design of Water Purification Facilities. (3)
Corequisite, ENCE 271 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. (Cookson)

ENCE 274. Design of Municipal and Industrial Wastes Treatment Facilities. (3)
Corequisite, ENCE 272 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. (Cookson)

ENCE 275. Biological Principles of Environmental Health Engineering. (4)
Prerequisite, MICR 101 or equivalent. Three lectures and one laboratory period a week. An exposition of biological principles directly affecting man and his environment; assay, control and treatment of biological and virological agents in water, sewage, and air; microbiology and biochemistry of aerobic and anerobic treatment processes for aqueous wastes. (Cookson)

ENCE 276. Industrial Wastes. (3)
Corequisite, ENCE 272, 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. (Cookson)

ENCE 277. The Chemistry of Natural Waters. (4)
Prerequisite, ENCE 176 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 solubility controls, pH, carbonate equilibria, absorption reactions redox reactions, and the kinetics of oxygenation reactions which occur in natural water environments. (Birkner)

ENCE 278. Applied Water Chemistry. (4)
Prerequisite, ENCE 277 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 des-

tabilization of colloidal materials, ion exchange, disinfection, chemical oxidation and oxygenation reactions. (Birkner)

ENCE 279. Aerosol Science and Technology. (3)
Three lectures per week. ENCE 145 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. (Israel)

ENCE 280. Air Sampling and Analysis. (3)
Two lectures and one laboratory a 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. (Israel)

STRUCTURAL ENGINEERING

For Graduates and Advanced Undergraduates

ENCE 102. Fundamentals of Structural Analysis. (3)
Three lectures each week. Prerequisites, ENES 020 and ENCE 050. (Reilly and Piper)

ENCE 103. Basic Structural Design. (3)
Three lectures each week. Prerequisite, ENCE 102. (Reilly and Piper)

ENCE 107. Fundamentals of Soil Mechanics. (3)
Three lectures each week. Prerequisites, ENES 020 and ENCE 050. (Witczak)

ENCE 125. Advanced Strength of Materials. (3)
Three lectures each week. Prerequisite, ENES 020. (Lepper)

ENCE 126. Experimental Stress Analysis. (4)
Three lectures and one laboratory each week. (Lepper and Wedding)

ENCE 127. Theory of Elasticity and Plasticity. (3)
Three lectures each week. Prerequisite, ENES 020 and ENCE 112.

ENCE 135. Advanced Soil Mechanics. (4)
Three lectures and one laboratory each week. Prerequisite, ENCE 107. (Witczak)

ENCE 136. Soil-Foundation Systems. (3)
Three lectures each week. Prerequisites: ENCE 107, 135 or equivalent with permission of instructor. (Witczak)

ENCE 155. Advanced Materials of Engineering. (3)
Three lectures each week. Prerequisite, ENCE 050. (Wedding)

ENCE 165. Structural Analysis. (3)
Three lectures each week. Prerequisite, ENCE 103. (Garber, Heins)

ENCE 166. Structural Design. (4)
Three lectures and one laboratory each week. Prerequisite, ENCE 103. (Garber, Heins)

For Graduates

ENCE 221, 222. Advanced Strength of Materials. (3, 3)
Prerequisites, ENES 020, 021 and ENCE 050 or equivalent. Analyses 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. (Lepper)

ENCE 223. Experimental Stress Analysis. (3)
Prerequisite, ENCE 221 or permission of instructor. Experimental methods of stress and strain analysis for static and impact forces. Use of structural models; brittle and plastic materials methods; analogies; photoelasticity; optical, mechanical and electrical strain gages and instrumentation (Wedding)

ENCE 224. Advanced Engineering Materials Laboratory. (3)
Prerequisite, ENES 020, 021, and ENCE 050 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. (Lepper, Wedding)

ENCE 225, 226. Advanced Properties of Materials. (3, 3)
Prerequisite, ENCE 221 and 222 or consent of instructor. Modern theories of the structure of matter applied to the study of elastic and plastic deformation of materials under static, repeated, sustained and impact forces, Elements of solid state physics, crystal structure, slip and dislocation theory; polycrystalline solids. Effects of low and high temperature, loading rates, and state of stress on mechanical properties and fractures. Critical study of tests and their application to strength of members. (Lepper)

ENCE 227, 228. Theories of Concrete and Granular Materials. (3, 3)
Prerequisites, ENCE 221, 222, 224 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. (Wedding)

ENCE 251. Soil Mechanics. (3)
Prerequisites, ENCE 107, 135 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. (Kondner)

ENCE 252. Advanced Foundations.(3)
Prerequisites, ENCE 107, 165 and 166, 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. (Kondner)

ENCE 255. Dynamics of Structures. (3)
Prerequisite, ENCE 112, 102, and 103 or equivalent. Analysis and design of structures subjected to dynamic loads. Hamilton's Principle and Lagrange's Equations. Rayleigh's Principle. Fourier and transform methods. Numerial and matrix methods used to solve continuous and lumped mass systems. Application to earthquake design, blast resistant structures, bridge vibration, and other civil engineering problems. (Staff)

ENCE 256. Matrix Methods of Structural Analysis. (3)
Prerequisite, ENCE 127 and ENCE 112 or equivalent. Review of basic structural and matrix theory. Use of virtual work and complementary virtual work to develop in parallel the displacement and force method for determinate and indeterminate civil engineering structures. Stiffness and flexibility matrices. Initial and thermal strain, modification and cutout procedure. Comparison of flexibility and displacement methods. Introduction to the dynamic response of structures using mode superposition and matrix methods. (Staff)

ENCE 257. Analysis of Plate and Shell Structures. (3)
Prerequisite, ENCE 125, ENCE 127 and ENCE 112 or equivalent. Review of fundamental formulas from the theory of surfaces. General theory for membrane stresses, bending stresses, deformation and stability of thin plates and shells. Application of the theory to civil engineering structures such as hyperbolic paraboloids, cylindrical shells, shells of revolution, shells of arbitrary shape, folded plates. (Heins)

ENCE 258. Advanced Elasticity. (3)
Prerequisite, ENCE 125, ENCE 127 and ENCE 112 or equivalent. Review of vector and tensor calculus. Invariant formulation of nonlinear theory including effect of large displacements, finite rotations and finite deformations, stability of equilibrium configurations. Special civil engineering problems solved by finding the system of forces which is necessary to maintain the deformed body in equilibrium. Theory of successive approximations. (Staff)

ENCE 259. Nonlinear Theory of Shell Structures. (3)
Prerequisite, ENCE 257 and ENCE 258. General formulation of a nonlinear theory of shells of arbitrary shape occurring in civil engineering structures utilizing basic concepts from vector and tensor analysis. Large deflections and rotations are considered consistent with the existence of a strain energy function which permits the derivation of a stress-strain relation. The shell problem is reduced to one of two dimensions by various procedures. After the general theory governing the equilibrium configuration of a shell structure is established, the condition of stable and unstable equilibrium is considered. (Staff)

ENCE 260. Plastic Analysis and Design of Structures. (3)
Prerequisite, permission of instructor. Theory of plasticity and its application to structural design. The behavior of steel structures beyond the elastic limit and up to collapse. Study of component parts of frames; methods of predicting strength and deformation in the plastic range. Studies of industrial type frames. Current research. Comparison of conventional design methods with plastic design techniques. (Heins)

ENCE 263. Theory of Structural Design. (3)
Prerequisite, ENCE 102, 103, 165 and 166, or equivalent. Advanced structural theory applied to the design of bridges and buildings. Methods of analysis for indeterminate structures, including movement distribution. Maxwell's method, virtual work, reciprocal theory, Muller Breslau's principle, and classical analytical methods. (Looney)

ENCE 264. Theory of Structural Design. (3)
Prerequisite, ENCE 263. Correlation of theory, experience, and experiments in study of structural behavior, proportioning, and preliminary design. Special design problems of fatigue, buckling, vibrations, and impact. (Looney)

ENCE 265, 266. Behavior of Structures. (3, 3)
Prerequisites, ENCE 263, and 264. A continuation of ENCE 264. Examination of the fundamental basis for the design of structures. Correlation of laboratory research, advanced structural theory and mechanics and design methods. Study of specifications, factor of safety and ultimate strength, in the relation between structural tests and design. (Looney)

ENCE 296, 297. Engineering Analysis and Computer Programming. (3, 3)
Prerequisite, consent of instructor. Application to elasticity, stability and buckling, vibrations, thin plates and shells, or other problems in the area of mechanics, structures and materials. (Staff)

RESEARCH, SEMINARS, AND SPECIAL TOPICS

ENCE 199. Special Problems. (3)
Prerequisite, senior standing. (Staff)

ENCE 290. Advanced Topics in Civil Engineering.
Prerequisite: Permission of instructor. May be taken for repeated credit, when identified by topic title. (Staff)

ENCE 298. SEMINAR.
Credit in accordonce with work outlined by the Department. Prerequisite, consent of the Department of Civil Engineering. (Staff)

ENCE 399. Thesis Research. (Master's Level)
Credit in accordance with work done. (Staff)

ENCE 499. Dissertation Research. (Doctoral Level)
(Staff)

CLASSICAL LANGUAGES AND LITERATURES

Professor: Avery.

The Department of Classical Languages and Literatures offers no program leading to the degrees of Master of Arts or Doctor of Philosophy at the present time. The following courses, however, are offered upon sufficient demand to fill the needs of graduate students in other fields, such as English, history and modern foreign languages, who may wish to work in Latin in connection with their degree programs in such fields. Students should consult their major professors with respect to application of credit hours in Latin to their graduate programs.

For Graduates and Advanced Undergraduates

Prerequisite, LATIN 061 or equivalent.

LATIN 101. Catullus and the Roman Elegiac Poets. (3)
Lectures and readings on Catullus as a writer of lyric, an imitator of the Alexandrians, and as a writer of elegy, and on Tibullus, Propertius and Ovid as elegists. The reading of selected poems of the four authors. Reports. (Avery)

LATIN 102. Tacitus. (3)
Lectures and readings on Greek and Roman historiography before Tacitus and on the author as a writer of history. The reading of selections from the Annals and Histories. Reports. (Avery)

LATIN 103. Roman Satire. (3)
Lectures and readings on the origins and development of Roman satire. The reading of selections from the satires of Horace, Petronius' Cena Trimalchionis, and the satires of Juvenal. Reports. (Avery)

LATIN 104. Roman Comedy. (3)
Lectures and readings on the origins and development of Roman comedy. The reading of selected plays of Plautus and Terence. Reports. (Avery)

LATIN 105. Lucretius. (3)
Lectures and readings on Greek and Roman Epicureanism. The reading of selections from the *De rerum natura*. Reports. (Avery)

LATIN 111. Advanced Latin Grammar. (3)
An intensive study of the morphology and syntax of the Latin language supplemented by rapid reading. (Avery)

LATIN 199. Latin Readings. (3)
Special Prerequisite, consent of instructor. The reading of one or more selected Latin authors from antiquity through the Renaissance. May be repeated with varying content. Reports. (Avery)

For Graduates

Prerequisite, LATIN 061 or equivalent.

LATIN 210. Vulgar Latin Readings. (3)
An intensive study of the phonology, morphology, and syntax of Classical Latin, followed by the study of the deviations of Vulgar Latin from the classical norms, with the reading of illustrative texts. The reading of selections from the Peregrinatio ad loca sancta and the study of divergences from classical usage therein, with special emphasis on those which anticipate subsequent developments in the Romance Languages. Reports. (Avery)

COMPARATIVE LITERATURE

Professors: Cooley, Evans, Freedman, Greenwood, Goodwyn, G. Jones, Herman, Korg, Levitine, Prahl, Salamanca, Salchenberger, Schaumann, D. Smith, Swigger, Walt, and Whittemore.

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

Current language, course, examination, Master of Arts thesis, and Doctor of Philosophy dissertation requirements for graduate degrees in comparative literature may be obtained from the Departmental office.

The program in comparative literature is administered by a committee made up of Professor Morris Freedman, English, Chairman; Dean Charles Manning, Arts and Sciences; Dean David Sparks, Graduate School; Professor William McBain, French and Italian; Professor George Jones, German; Professor George Panichas, English; and Professor Ronald Swigger, Comparative Literature. Other departments cooperating in the program are Art, Classical Languages, Germanic and Slavic Languages and Literatures, Spanish and Portuguese, and the program in Hebrew, Chinese and Linguistics.

For Graduates and Advanced Undergraduates

CMLT 101. Introductory Survey of Comparative Literature. (3) (Schaumann)

CMLT 102. Introductory Survey of Comparative Literature. (3) (Schaumann)

CMLT 103. The Old Testament as Literature. (3) (Greenwood)

CMLT 104. New Testament as Literature. (3) (Greenwood)

CMLT 105. Romanticism: Early Stages. (3) (Swigger)

CMLT 106. Romanticism: Flowering and Influence. (3) (Swigger)

CMLT 107. The Faust Legend. (3) (Prahl)

CMLT 112. Ibsen and the Continental Drama. (3) (Smith)

CMLT 114. Greek Drama. (3)
(Prahl)

CMLT 115, 116. The Classical Tradition and Its Influence in the Middle Ages and Renaissance. (3, 3)
(Schaumann)

CMLT 125. Literature of the Middle Ages. (3)
(Cooley)

CMLT 130. The Continental Novel. (3)
(Swigger, Walt)

CMLT 135. Dante and the Romance Tradition. (3)
(Longen)

CMLT 140. Literature of the Far East. (3)
(Evans)

CMLT 141. Literature of the Far East. (3)
(Evans)

CMLT 145. Major Contemporary Authors. (3)
(Salamanca, Swigger)

CMLT 147. Genres. (3)
(Staff)

CMLT 150. Conference Course in Comparative Literature. (3)
By permission only. (Swigger)

For Graduates

CMLT 201. Problems in Comparative Literature. (3)
(Swigger)

CMLT 225. Medieval Epic. (3)
(Jones)

CMLT 226. The Medieval Romance. (3)
(Herman)

CMLT 230. Problems of the Baroque in Literature. (3)
(Staff)

CMLT 235. Seminar in Italian Renaissance and Its Influence. (3)
(Salchenberger)

CMLT 240. Literary Criticism: Ancient and Medieval. (3)
(Greenwood)

CMLT 241. Literary Criticism: Renaissance and Modern. (3)
(Staff)

CMLT 258. Folklore in Literature. (3)
(Goodwyn)

CMLT 268. Seminar in Literary Sources of Art History. (3)
(Levitine)

CMLT 301. Seminar in Themes and Types. (3)
(Staff)

CMLT 399. Thesis Research. (Master's Level)
(Staff)

CMLT 499. Dissertation Research. (Doctoral Level)
(Staff)

COMPUTER SCIENCE

Professors: Atchison *(Director of the Computer Science Center)*, Chu,* Edmundson,** Glasser,[1] Heilprin,[2] and Kanal.
Research Professors: Ortega,[3] Rheinboldt,[3] and Rosenfeld.
Associate Professors: Glaser,[4] and Minker.
Assistant Professors: Austing, Basili, Feldman, Hagerty, Hanani, McClellan, Owings,** Park, Pfaltz, and Vandegraft.

The educational program in computer science is administered by the Computer Science Center, an independent academic unit of the University. Graduate programs leading to the Master of Science and Doctor of Philosophy degrees are offered in the following areas: applications, computer systems, information processing, numerical methods, and theory and metatheory. The Center also provides computer service for all academic activities of the University.

Admission requirements include adequate undergraduate preparation in a related discipline, a calculus sequence plus at least one upper division mathematics course, and competence in the use of an assembly language and at least one higher level language. These requirements are considered minimal and additional undergraduate study in mathematics and computer science is desirable.

For additional information on admission and degree requirements and on financial support, students should write to the Admissions and Financial Awards Committee of the Center.

For Advanced Undergraduates and Graduates

*CMSC 100. Language and Structure of Computers. (3)
Two lectures and one two-hour laboratory period per week. Prerequisite, CMSC 12 or CMSC 20 or equivalent. Logical basis of computer structure, machine representation of numbers and characters, flow of control, instruction codes, arithmetic and logical operations, indexing and indirect addressing, input-output, push-down stacks, symbolic representation of programs and assembly systems, subroutine linkage, macros, interpretive systems, and recent advances in computer organization. Several computer projects to illustrate basic concepts.

*CMSC 102. Introduction to Discrete Structures. (3)
Prerequisite, CMSC 20 or equivalent. This is the same course as ENEE 102. 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.

*CMSC 110. Special Computational Laboratory. (1 or 2)

*Joint appointment with Electrical Engineering
**Joint appointment with Mathematics
[1] Joint appointment with Physics and Astronomy
[2] Joint appointment with Library and Information Services
[3] Joint appointment with Institute for Fluid Dynamics and Applied Mathematics
[4] Joint appointment with Physiology
*These courses may not be counted for credit in the graduate program in Computer Science.

*CMSC 120. Introduction to Computer Languages and Systems. (3)
Prerequisite, MATH 22 or equivalent. 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 132. Simulation of Continuous Systems. (3)
Prerequisites, CMSC 20 and MATH 66, 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 140. Structure of Programming Languages. (3)
Prerequisite, CMSC 100 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 144. Elementary Logic and Algorithms. (3)
Prerequisite, MATH 21 or consent of instructor. This is the same course as MATH 144. 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 150. Data and Storage Structures. (3)
Prerequisites, CMSC 100 and 102, or equivalent. A study of intrinsic structures of data, such as arrays, strings, trees, and lists, and their relation to storage media. Representation of data structures in storage by records, files, etc. Special storage structures such as content addressed, trie, and associative memories. Referencing, processing, and management techniques based on the structuring, e.g., list processing. Storage and accessing efficiency, as well as dynamic flexibility of various methods.

CMSC 160. Computer Organization. (3)
Prerequisite, CMSC 100 or equivalent. This is the same course as ENEE 166. 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 168. Numerical Methods for Scientists and Engineers. (3)
Prerequisites, Math. 22 or 162, Math. 66, and CMSC 20 or equivalent. This is the same course as Math. 168. Interpolation, numerical differentiation and integration, numerical solution of polynomial and transcendental equations, least squares, systems of linear equations, numerical solution of ordinary differential equations, errors in numerical calculations.

CMSC 170. Numerical Analysis I. (3)
Pre- or co-requisite, Math. 110. This is the same course as Math. 170. Solution of linear systems of equations and nonlinear equations in one variable. Least square and Chebyshev approximation. Numerical differentiation, integration, and solution of ordinary differential equations.

*These courses may not be counted for credit in the graduate program in Computer Science.

CMSC 171. Numerical Analysis II. (3)
Prerequisites, Math. 100 or 104, Math. 110, and CMSC/M. 170. This is the same course as Math. 171. Linear systems of equations: norms, condition numbers, rounding error analysis, iterative methods; introduction to numerical solution of partial differential equations. Nonlinear systems of equations: Newton's method, convergence and rate of convergence. Eigenvalue problems.

CMSC 190. Special Problems in Computer Science. (1-3)

For Graduates

CMSC 200. Programming Systems. (3)
Prerequisites, CMSC 140, 150, and 160. 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 202. Computer Systems. (3)
Prerequisite, CMSC 160 or equivalent. Computer organization. Memory logic. Control logic. Numerical processors. Non-numerical processors. Computer architecture. On-line computer systems. Time-sharing computer systems. Computer networks. Analog and hybrid computer systems.

CMSC 204. Information Processing. (3)
Prerequisites, CSMC 140 and 150. 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 system. Processing of numeric data, formula processing. Processing of natural-language text. Picture processing. Machine intelligence. Applications to cognitive processes and problem-solving.

CMSC 206. Computability and Automata. (3)
Prerequisite, CMSC 144, 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 210. Theories of Information. (3)
Prerequisites, CSMC 204 and STAT 101. Mathematical and logical foundations of existing theories of information. Topics covered 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 215. Theory of Computability. (3)
Prerequisite, CMSC 206. Algorithms; Church's thesis. Primitive recursive functions; Gödel numbering. General and partial recursive functions. Turing machines; Turing's thesis. Markov algorithms. Church's lamda calculus. Grzegorczyk hierarchy; Peter hierarchy. Relative recursiveness. Word problems, Post's correspondence problem.

CMSC 220. Automata Theory. (3)
Prerequisite, CMSC 206. This is the same course as ENEE 265. 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.

CMSC 225. Computer Applications to the Physical Sciences. (3)
Prerequisite, CMSC 100, STAT 100, 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 230. Simulation of Computers and Software. (3)
Prerequisite, CMSC 160 or equivalent. Computer simulation language, macro and micro simulation, boolean translation, software-hardware transformation, description and simulation of a microprogrammed computer, construction and simulation of an assembler, project for unified hardware-software design.

CMSC 235. Modeling and Simulation of Physical Systems. (3)
Prerequisites, CMSC 100 and STAT 101. 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 240. Translation of Programming Languages. (3)
Prerequisites, CMSC 140 and 150. Application of theoretical concepts developed in formal language and automata theory to the analytic design of programming languages and their processors. Theory of pushdown 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 245. Theory of Formal Languages. (3)
Prerequisite, CMSC 206. Formal grammars; syntax and semantics. Post productions; Markov algorithms. Finite-state languages, parsing, trees, and ambiguity. Theory of regular sets. Context-free languages; pushdown automata. Context-sensitive languages; linear-bounded automata. Unrestricted rewriting systems; Turing machines. Closure properties of languages under operations. Undecidability theorems.

CMSC 250. Mathematcial Linguistics. (3)
Prerequisites, CMSC 206 and Stat. 100. Introductory course on applications of mathematics to linguistics. Elementary ideas in phonology, grammar, and semantics. Automata, formal grammars and languages. Chomsky's theory of transformational grammars, Yngve's depth hypothesis and syntactic complexity. Markov-chain models of word and sentence generation, Shannon's information theory, Carnap and Bar-Hillel's semantic theory, lexicostatistics and stylostatistics, Zipf's law of frequency and Mandelbrot's rank hypothesis. Mathematical models as theoretical foundation for computational linguistics.

CMSC 252. Computational Linguistics. (3)
Prerequisite, CMSC 204. 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 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 255. Information Retrieval. (3)
Prerequisite, CMSC 204. This course is 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 258. Topics in Information Science. (3)
Prerequisite, permission of the instructor. This is the same course as LBSC 258. 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 265. Advanced Automata Theory. (3)
Prerequisite, CMSC 220. 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 266. Algorithmic Numerical Analysis. (3)
Prerequisites, CMSC. 100 and 168 or Math. 171. A detailed study of problems which arise in the implementation of numerical analysis algorithms in a computer. Rounding and truncation error. Automatic error estimates using interval arithmetic and convergence theorems. Examples from linear algebra, differential equations, minimization.

CMSC 280. Artificial Intelligence. (3)
Prerequisites, CMSC. 204 and Stat. 101. 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, "ϕ", and multilayer machines. Statistical decision theory, decision functions, liklihood ratios; mathematical taxonomy, cluster detection. Neural models, computational properties of neural nets, processing of sensory information, representative conceptual models of the brain.

CMSC 285. Computer Processing of Pictorial Information. (3)
Prerequisite, CMSC. 204. 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 290. Advanced Topics in Computer Science. (3)

CMSC 295. Graduate Seminar in Computer Science. (13)

CMSC 399. Thesis Research.
Arranged.

CMSC 499. Dissertation Research
Arranged.

DAIRY SCIENCE

Professors: Arbuckle, Cairns, Davis, Keeney, King, Mattick, and Williams.
Associate Professor: Vandersall.
Assistant Professors: Buchman, Bull, Douglass, and Westhoff.

The Department of Dairy Science offers work leading to the degree of Master of Science and Doctor of Philosophy. Candidates for the Doctor of Philos-

ophy degree have the option of studying in one of two major fields: dairy production, which is concerned with breeding, nutrition and physiology of dairy animals; or dairy technology, which is concerned with chemical, bacteriological and nutritional aspects of dairy products, as well as the industrial phases of milk processing. Students interested in food science may undertake graduate study in the dairy technology phase of Dairy Science, or in the food science curriculum.

DAIRY TECHNOLOGY (Food Science)

For Graduates and Advanced Undergraduates

FDSC 103. Principles of Food Processing II. (3)
See Food Science for description. (Mattick)

FDSC 111. Food Chemistry. (3)
See Food Science for description. (King)

FDSC 160. Technology of Market Eggs and Poultry.
See Food Science for description. (Staff)

FDSC 182. Dairy Products Processing. (3)
See Food Science for description. (Mattick)

Mechanics of Food Processing.
See AGEN 113

Experimental Food Science.
See Home Economics, FOOD 153.

For Graduates

FDSC 201. Advances in Food Technology. (3)
See Food Science for description. (Kramer)

Research Methods.
See Dairy Prod., ANSC 241.

Methods of Horticultural Research.
See Horticulture, HORT 207.

FDSC 301. Special Problems in Food Science. (1-4)
See Food Science for description. (Staff)

FDSC 302. Seminar in Food Science. (1-3)
See Food Science for description. (Staff)

FDSC 310. Colloquium in Food Science. (1)
See Food Science for description. (Staff)

FDSC 399. Thesis Research. (Master's Level)
See Food Science for description.

FDSC 499. Thesis Research. (Doctoral Level)

DAIRY PRODUCTION

For Graduates and Advanced Undergraduates

ANSC 109. Fundamentals of Nutrition. (3)
(Thomas)

ANSC 110. Applied Animal Nutrition. (3)
First semester. Two lectures and one laboratory period per week. Prerequisite. MATH 010. ANSC 109 or permission of instructor. (Vandersall)

ANSC 116. Anatomy of Domestic Animals. (3)
(Albert)

ANSC 117. Introduction to Diseases of Animals.
(Albert)

ANSC 118. Wildlife Management. (3)
(Flyger)

ANSC 130. Principles of Breeding. (3)
(Green)

ANSC 140. Physiology of Mammalian Reproduction. (2)
First semester. One lecture and one three-hour laboratory period per week. Prerequisite, ZOOL 102 or 104. (Williams)

ANSC 141. Applied Animal Physiology. (4)
Second semester. Three lectures and one three hour laboratory period per week. Prerequisites. CHEM. 31 and ANSC 116 or equivalent. The physiology of domesticated animals with emphasis on functions related to production and physiological adaptation to environmental influences. (Williams)

ANSC 142. Dairy Cattle Breeding. (3)
Second semester. Two lectures and one laboratory per week. Prerequisites. ANSC 040, ZOOL 006, or BOTN 117. A specialized course in breeding dairy cattle. (Douglass)

ANSC S143. Advanced Dairy Production. (1)
Summer session only. An advanced course primarily designed for teachers of vocational agriculture and county agents. It includes a study of the newer discoveries in dairy cattle nutrition, breeding and management. (Staff)

ANSC 189. Special Topics in Fish and Wildlife Management. (3)
(Flyger)

For Graduates

ANSC 220. Advanced Breeding. (2)
See Animal Science for description. (Green)

ANSC 221. Energy and Protein Nutrition. (3)
See Animal Science for description. (Leffel and Combs)

ANSC 240. Advanced Ruminant Nutrition. (2)
First semester. Two one-hour lectures and one two-hour laboratory per week. Prerequisite, permission of department. Biochemical, physiological and bacteriological aspects of the nutrition of ruminants and other animals. (Vandersall)

ANSC 241. 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. (Staff)

ANSC 242. 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 243. Experimental Mammalian Surgery II. (3)
Second semester. Prerequisites, ANSC 242, 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 261. Physiology of Reproduction. (3)
See Poultry Science for description. (Shaffner)

ANSC 263. Poultry Nutrition Laboratory. (2)
See Poultry Science for description. (Staff)

ANSC 264. Vitamins. (2)
See Poultry Science for description. (Staff)

ANSC 265. Mineral Metabolism. (2)
See Poultry Science for description. (Bull)

ANSC 266. Physiological Genetics of Domestic Animals. (2)
See Poultry Science for description.

ANSC 280. Seminar in Population Genetics of Domestic Animals.
See Poultry Science for description. (Godfrey)

ANSC 301. Special Problems in Animals Science. (1-3) (4 cr. max.)
First and second semesters. Prerequisite, approval of staff. Work assigned in proportion to amount of credit. Problems will be assigned which relate specifically to the character of work the student is pursuing. (Staff)

ANSC 302. Seminar. (1) (5 cr. max.)
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; (2) Nutrition; (3) Physiology; (4) Biochemistry. (Staff)

ANSC 399. Thesis Research. (Master's Level)
First and second semesters. Work assigned in proportion to amount of credit. Students will be required to pursue original research in some phase of animal science, carrying the same to completion, and report the results in the form of a thesis. (Staff)

ANSC 499. Dissertation Research. (Doctoral Level)
(Staff)

ECONOMICS

Professors: Dillard, Almon, Cumberland, Gruchy, Olson, O'Connell, Schultze, Ulmer, and Wonnacott.
Associate Professors: Aaron, Bennett, Bergmann, Dodge, Dorsey, Harris, Knight, McGuire, Meyer, and Weinstein.
Assistant Professors: Adams, Atkinson, Betancourt, Boorman, Clague, Greer, MacRae, Meer. Qualls, Singer, and Tilton.
Lecturers: Amuzegar, Andersen, Dardis, Denny, Green, Harrison, Hinrichs, Karlik, Lady, Layher, McLoone, Measday, Mills, Moore, Pierce Schiller, Schink, Shipley, Snow, Strayhorn, and Whitman.

The First Year of Graduate Work in Economics. Because nearly all the advanced graduate courses require a thorough working knowledge of economic

theory and quantitative methods a student's first year program normally includes Economics 200, 202, and 211 in the fall, and Economics 201, 247, and 212 in the spring. Three courses per semester constitute full-time work for students with assistantships or internships; students who can devote full time to courses normally take four.

DOCTOR OF PHILOSOPHY

1. *Written Theory Examination.* At the beginning of his second year, the student takes a written examination in economic theory. The examination may be repeated twice, if necessary, but it must be passed before the student can take the comprehensive examinations described in (4), below. This examination is given in September and February.

2. *Course and Seminar Paper Requirements.* The student must pass satisfactorily:

a. Economics 211 and 212, Quantitative Methods, or be exempted from them by examination or former work. These courses should be taken in the first year of study if possible.

b. Economics 230 and 231, History of Economic Thought, or be exempted from them on the basis of equivalent graduate work elsewhere.

c. Two courses, other than those in (a) or (b), *not* in the fields which he presents on his comprehensive examinations.

He must also select a major field and prepare a seminar paper in that field. This paper must be presented at the oral comprehensive examination and should, if possible, lead to a Doctor of Philosophy thesis. Usually additional courses are taken to prepare for the comprehensive examinations.

3. *Language Requirements.* The Department requires either a high degree of competence in one language or basic proficiency in two. In the second case, a course numbered above 100 in mathematics or above 99 in statistics may replace one language.

4. *Comprehensive Examinations.* The Doctor of Philosophy candidate must pass written examinations in two fields selected, with the approval of his adviser, from the following list:

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
Money and Banking
Public Finance
Regional and Urban Economics
Any other field approved by the faculty

The comprehensive examinations will be given in October and late April. Students should sign up for them one month in advance, and should take both examinations in the same semester. Soon after successful completion of

the written examinations, the candidate must take an oral examination covering economic theory, the two fields of the written examinations and the seminar paper. Upon the recommendation of the examining committee (when approved by the Graduate Council), he will be admitted to candidacy for the Ph.D. These examinations should be passed before the end of the candidate's third year of graduate study.

5. *Doctoral Dissertation*. Writing a doctoral dissertation and its successful defense in an oral examination completes the program. The Department conducts a doctoral dissertation seminar in which the student will be asked once a year to discuss the progress on his thesis.

6. *Minor Requirements*. A program satisfying the above requirements automatically satisfies The Graduate School's major and minor requirements.

MASTER OF ARTS, NON-THESIS OPTION

Under this option the candidate must: (a) pass with an average grade of "B" or better at least 30 hours of courses (not counting 399 or 499)—24 of these hours must be in 200-level courses, and they must include Economics 211 and 212 with "B" or better; (b) pass the written portion of the comprehensive theory examination which is part of the Doctor of Philosophy program; and (c) prepare an acceptable seminar paper in a graduate level course in economics or prepare a similar paper independent of a course (in the case of an independent paper a committee will be appointed to evaluate it).

MASTER OF ARTS, THESIS OPTION

The student must pass 24 semester hours of course work, plus six hours of thesis supervision. Twelve semester hours, exclusive of thesis supervision, must be in courses numbered 200 to 299. He must take one course in micro-economic theory, one in aggregate economic theory and one in quantitative methods, unless equivalent work has been done elsewhere. (In practice, because most of the advanced graduate courses build on those mentioned under "The First Year" above, the master's program will usually include at least 12 hours in these courses.) Finally, he must write an acceptable thesis and pass an oral examination on the thesis, economic theory and the field in which the thesis is written.

ADMISSION

Applications for admission and financial assistance received by March 1 will be given priority; the closing date is July 15. All applicants are urged to take the Graduate Record Examination; information on this may be obtained from Educational Testing Service, Princeton, N.J.

Applicants should normally have taken or plan to take before enrolling at least one course in each of the following: price theory, macro theory, calculus, and statistics Applicants who intend to be part-time students should bear in mind that most graduate courses are taught during the day and that the minimum course load requires about 30 hours of work per week.

Direct inquiries to Director of Graduate Studies in Economics.

For Graduates and Advanced Undergraduates

ECON 102. National Income Analysis. (3)
First and second semesters. Prerequisite, ECON 032. (Moore, Layher, O'Connell)

ECON 103. American Economic Development. (3)
Prerequisite, ECON 032 or 037. (Shipley)

ECON 105. Introduction to Economic Development of Underdeveloped Areas. (3)
Prerequisite, ECON 032 or 037. (Adams, Betancourt)

ECON 106. Economic Development of Selected Areas. (3)
Prerequisite, ECON 105. ECON 106A—Latin America; ECON 106B—Asia; ECON 106C —Africa. (Adams, Betancourt)

ECON 111. Quantitative Methods in Economics. (3)
(Betancourt, Schink)

ECON 112. Quantitative Methods in Economics II. (3)
Prerequisites, ECON 102, 132, 111, and 130 or consent of instructor. (Boorman, McRae)

ECON 120. Introduction to Regional and Urban Economics. (3)
Prerequisite, ECON 102, or consent of instructor. (Harris)

ECON 130. Mathematical Economics. (3)
First semester. Prerequisite, ECON 102 and 132 and one year of college mathematics. (MacRae)

ECON 131. Comparative Economic Systems. (3)
First and second semesters. Prerequisite, ECON 032 or 037. (Gruchy, Denny, Amuzegar)

ECON 132. Intermediate Price Theory. (3)
First and second semesters. Prerequisite, ECON 032. Required for economics majors; an analysis of price and distribution theory with special attention to recent developments in the theory of imperfect competition. (Harrisan, Day, Dardis)

ECON 134. Contemporary Economic Thought. (3)
Prerequisite, ECON 032 and senior standing. (Gruchy)

ECON 137. The Economics of National Planning. (3)
Prerequisite, ECON 032 or 037. (Gruchy, Almon)

ECON 138. Economics of the Soviet Union. (3)
Prerequisite, ECON 032 or 037. (Dodge)

ECON 139. The Economy of China. (3)
Prerequisite, ECON 032 or 037. (Denny)

ECON 140. Money and Banking. (3)
First and second semesters. Prerequisite, ECON 032. (Meyer, Strayhorn, Boorman)

ECON 141. Theory of Money, Prices and Economic Activity. (3)
Second semester. Prerequisite, ECON 102, 132, and 140 or consent of instructor. (Boormon, Meyer)

ECON 142. Introduction to Public Finance. (3)
First and second semesters. Prerequisite, ECON 032. (Meer, Hinrichs, McLoone)

ECON 143. Theory of Public Finance. (3)
Second semester. Prerequisite, ECON 142, 102 and 132, or consent of instructor. (Singer)

ECON 144. State and Local Public Finance. (3)
Prerequisite, ECON 032 or 037. (Whitman)

ECON 147. Business Cycles. (3)
First semester. Prerequisite, ECON 102. (Almon)

ECON 148. International Economics. (3)
First and second semesters. Prerequisite, ECON 032.
(Wonnacott, Clague, Moore, Atkinson)

ECON 149. International Economic Policies. (3)
Prerequisite, ECON 148, 102, and 132, or consent of instructor. (Atkinson)

ECON 160. Labor Economics. (3)
First and second semesters. Prerequisite, ECON 032. (Knight, Weinstein)

ECON 161. Current Problems in Labor Economics. (3)
Second semester. Prerequisite, ECON 160. (Weinstein, Knight)

ECON 165. Economics of Poverty and Discrimination. (3)
Prerequisite, ECON 032 or 037. (Schiller)

ECON 170. Industrial Organization. (3)
Prerequisite, ECON 032 or 037. (Qualls, Tilton)

ECON 171. Economics of American Industries. (3)
Second semester. Prerequisite, ECON 032 or 037. (Measday, Greer)

ECON 190. Topics in Economics. (3)

ECON 200. Micro-Economic Analysis. (3)
First semester. This course and its sequel, ECON. 201, analyze the usefulness and the 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 211 is presumed.
(Ulmer, Olson, Pierce)

ECON 201. Advanced Micro-Economic Analysis. (3)
Second semester. Prerequisite, ECON 200. A continuation of ECON 200. Theory of capital, interest and wages. Qualifications of the basic welfare theorem caused by non-competitive 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.
(Ulmer, Almon, Pierce)

ECON 202. Macro-Economic Analysis. (3)
First semester of a two-semester sequence (along with ECON 247). Topics normally include general equilibrium theory in classical, Keynesian, and post-Keynesian treatments; the demand for money; theories of consumption behavior and of inflation.
(Aaron, Pierce)

ECON 204. Origins and Development of Capitalism. (3)
Studies the transition from feudalism to modern capitalistic economies in Western Europe. Whenever possible. this economic history is analyzed with the aid of tools of modern economics, and in the light of comparisons and contrasts with the less developed areas of the present day. (Olson)

ECON 205. Economic Development of Underdeveloped Areas. (3)
First semester. Prerequisite, ECON 102 and 132. 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. (Bennett)

ECON 206. Seminar in Economic Development. (3)
Second semester. Prerequisite, ECON 205 or consent of instructor. A continuation of ECON 205. Special emphasis is on the application of economic theory in the institutional setting of a country or area of particular interest to the student.
(Bennett, Adams)

ECON 207. 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. (Bennett)

ECON 209. Welfare Economics. (3)
Prerequisite, ECON 200. The topics covered include Pareto optimality, social welfare functions, indivisibilities, consumer surplus, output and price policy in public enterprise, and the welfare aspects of the theory of public expenditures. (McGuire, Olson)

ECON 211. 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. (Bergmann, Boorman, Green)

ECON 212. Quantitative Economics II. (3)
Second semester. Prerequisite, ECON 211. 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.
(Bergmann, Boorman, Green)

ECON 214. 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 211 and ECON 212. (Almon)

ECON 215. Seminar in Mathematical Economics. (3)
Second semester. Prerequisite, ECON 214. The topic of the seminar changes from year to year. (Almon)

ECON 217. Econometrics. (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. (Almon)

ECON 218. Seminar in Quantitative Economics. (3)
Second semester. Prerequisite, ECON 212 or consent of instructor. Analysis of data sources for economic research; critical evaluation of previous and current quantitative economic studies; and class discussion and criticism of student research projects.
(Almon)

ECON 220. 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. (Cumberland)

ECON 221. 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. (Harris)

ECON 230. History of Economic Thought. (3)
First semester. Prerequisite, ECON 132 or consent of the instructor. A study of the development of economic thought and theories including the Greeks, Romans, canonists, mercantilists, physiocrats, Adam Smith, Malthus, Ricardo. Relation of ideas to economic policy. (Dillard)

ECON 231. Economic Theory in the Nineteenth Century. (3)
Second semester. Prerequisite, ECON 230 or consent of the instructor. A study of nineteenth and twentieth-century schools of economic thought, particularly the classicists, neo-classists, Austrians, German historical school, American economic thought, the socialists, and Keynes. (Dillard)

ECON 232, 233. Seminar in Institutional Economic Theory. (3, 3)
A study of the recent developments in the field of institutional economic theory in the United States and abroad. (Gruchy)

ECON 234. Economic Growth in Mature Economies. (3)
Analysis of policies and problems for achieving stable economic growth in mature economies such as the United States, and the major West European countries. (Gruchy)

ECON 235. 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. (Wonnacott, Clague)

ECON 236. Seminar in International Economic Relations. (3)
Second semester. Selected problems in international economics. (Wonnacott)

ECON 237. Selected Topics in Economics. (3)
Arranged individually with professors.

ECON 238. Seminar in Economic Development of the Soviet Union. (3)
Second semester. Prerequisite, ECON 138 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 economics administration, manpower and wage policies, foreign trade and aid. Selected topics in Bloc development and reform. (Dodge)

ECON 240. 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 contributions; emphasis on post-Keynesian contributions, including those of Tobin, Patinkin, Gurley-Shaw, Friedman, and others. (Meyer)

ECON 241. Seminar in Monetary Theory and Policy. (3)
Second semester. Prerequisite, ECON 240 or consent of instructor. Theory of the mechanisms through which central banking affects economics activity and prices; formation and implementation of monetary policy; theoretical topics in monetary policy. (Meyer)

ECON 242. 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 productions, exchange and consumption. Principles of benefit-cost analysis for government decisions. (Schultze)

ECON 243. 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. (Aaron)

ECON 245. 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. (McGuire, Singer)

ECON 246. Public Sector Workshop. (3)
Second semester. Representative problems in analysis for public decision making: measurement of benefits and costs; incommensurabilities in benefits, and ambiguities in cost; criteria for program and project selection; effects of uncertainty; time horizon considerations; joint costs and multiple benefits; non-quantifiable factors in decision analysis. Examples will be taken from current government programs. (McGuire)

ECON 247. Economic Growth and Instability. (3)
Second semester of a two-semester sequence (along wth ECON 202). Major topics include growth and technological change, investment, business cycles, and recent developments in large empirial macroeconomic models. Also included are material on wages and employment and on international and domestic stability. (Bergmann, Pierce)

ECON 248. 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. (Tilton)

ECON 260. 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. (Knight, Weinstein)

ECON 261. 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. (Knight)

ECON 265. Seminar in the Economics of Poverty and Discrimination. (3)
Prerequisites, ECON 211 and 212. A review of the economic literature in poverty and discrimination. The course will also function as a workshop in which research of the staff and students is presented. (Bergmann)

ECON 266. Seminar in the Economics of Human Resources. (3)
Prerequisite, consent of the instructor. (McLoone)

ECON 270. Advanced Industrial Organization. (3)
First semester. Prerequisite, ECON 102 and 132 or consent of instructor Analysis of market structure and its relation to market performance. (Greer)

ECON 271. Industrial Organization and Public Policy. (3)
Second semester. Prerequisite, ECON 270 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. (Greer)

ECON 399. Thesis Research.
Arranged.

ECON 499. Dissertation Research.

EDUCATION

Professors: J. P. Anderson, V. E. Anderson, Berman, Blough, Bowie, Byrne, Carbone, Duffey, Giblette, Grambs, Grentzer, Harrison, Hebeler, Hornbake, Hovet, Hoyt, Kurtz, Leeper Lockard, Luetkemeyer, Magoon, Male, Maley, Marx, McClure, Mershon, Morgan, Newell, O'Neill, Perkins, Raths, Risinger, Schindler, Stunkard, Thompson, vanZwoll, Waetjen, Wiggin, and Wilson.

Associate Professors: Adkins, Agre, Allan, Amershek, C. R. Anderson, Ashlock, Beatty, Blum, Bolea, Brigham, Campbell, Carr, Chambliss, Chapin, Crosby, Dayton, Dittmann, Dudley, Farrell, Funaro,, A. Gardner, M. Gardner, Goering, Goldman, Greenberg, Hall, Hatfield, Henkelman, Herman, Hoops, M. L. James, Johnson, Kelsey, Kyle, Lawrence, Lemmon, Lindsay, Longley, Martin, Matteson, McLoone, McWhinnie, Menefee, Mietus, Milhollan, Moyer, Noll, Perrin, Peters, Pumroy, Ray, Rhoads, Roderick, Rogolsky, Seidman, Simms, Stern, Sullivan, Taylor, Tierney, Walbesser, Weaver, Wedberg, Williams, Woolf, and Zachary.

Assistant Professors: L. Anderson, Ansello, R. Bennett, S. Bennett, Bialik, Birk, Brabble, Carlson, Cirrincione, Collins, M. Davidson, Dietz, Eley, Eliot, Fey, Finkelstein, Flatter, Flores, Gantt, Gettle, H. Green, K. Green, Gump, Hardy, Haugen, Hempstead, Hopkins, Huden, Huebner, Hunt, Hutchings, Jacobs, E. James, Kafka, Krieger, Layman, Love, Maccini, McCuaig, McDaniels, Medvene, O'Donnell, Quigley, Rogers, Schafer, Schumacher, Sedlacek, Spielbichler, Stough, Tetrault, Wirth, Wolvin, Wrenn, and Yawkey.

Lecturer: Willard.

MASTER OF ARTS AND MASTER OF EDUCATION
ADVANCED GRADUATE SPECIALIST IN EDUCATION
DOCTOR OF PHILOSOPHY AND DOCTOR OF EDUCATION

Programs in a variety of educational specialities are offered through three levels of degree and diploma programs. In consultation with an adviser, a student may choose at the first level to qualify for the degree of Master of Arts or Master of Education. A high degree of professional competence is required for the Advanced Graduate Specialist diploma at the second level but in a separate stream from the degree programs. Both the Doctor of Education and the Doctor of Philosophy degrees are offered at the third level. The master's and doctoral degrees come under the jurisdiction of The Graduate School. For the AGS diploma, a student must be matriculated in The Graduate School but the program is under the control of the College of Education.

The student is required to take a test battery, and to submit professional recommendations.

MAJOR AREAS

Following is a list of major areas.* Note that some majors can be pursued only at the master's level, whereas others are primarily AGS or doctoral pro-

*See Director of Graduate Studies in Education for information about levels.

grams. *For policies and procedures respecting all degree and diploma programs, see bulletins issued by the Department of Education.*

Academic Education (These are emphases within the areas of Elementary or Secondary Education, with work in Higher Education for doctoral students.)
- (1) Art Education
- English (Language Arts) Education
- Foreign Language Education
- Mathematics Education
- Music Education
- Science Education
- Social Studies Education
- (1) Speech Education

Administration, Supervision and Curriculum
- General Administration including
- (3) Curriculum Development
- Educational Technology
- Personnel Administration
- Public Relations
- School Facilities
- Supervision of Instruction
- School Finance and Business Management
- Administration in High Education
- Administration in Secondary Education
- Administration in Elementary Education

(1) Adult Education
- Counseling and Personnel Services
- Counseling
  - Child and elementary
  - College
  - Community
  - Secondary
  - Rehabilitation
- Psychological Services in Schools
- Pupil Personnel Worker
- Student Personnel Administration

(5) Corrective and Remedial Reading

(4) Curriculum and Instruction

(1) Education for Industry
Elementary Education

(2) Higher Education
Historical, Philosophical, and Sociological Foundations of Education; Comparative Education
Human Development Education
Industrial Arts Education

(1) Nursery-Kindergarten Education

(5) Reading
Measurement and Statistics
Secondary Education
Special Education
- General
- Emotionally Disturbed
- Gifted
- Mentally Retarded
- Perceptually Impaired
- Diagnostic-Prescriptive Teaching

(1) Technical Education
Vocational Education
- Business Education
- (1) Distributive Education
- Home Economics Education
- Vocational Industrial Education

(1) Master's only.

(2) At AGS level as junior college education. At doctoral level, hyphenated with other majors for preparation of college and university personnel.

(3) Curriculum in this major is primarily for school service personnel.

(4) Curriculum in this major is primarily for college and university professors of curriculum.

(5) Master's and AGS levels only except when part of a broader major in elementary or secondary education.

GENERAL EDUCATION

For Graduates and Advanced Undergraduates

EDUC 100. History of Education in Western Civilization. (3)
(Lindsay)

EDUC 102. History of Education in the United States. (3)
(Finkelstein, Wiggin)

EDUC 107. Philosophy of Education. (2) (3)
(Agre, Noll)

EDUC 108. Logic of Teaching. (3)
(Agre)

EDUC 146. Quantitative Research Methods I. (3)
(Staff)

EDUC 147. Audiovisual Education. (3)
(Hempstead, Wedberg)

EDUC 148. Instructional Media Services. (3)
Prerequisites: teaching experience and EDUC 147, 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. (Wedberg)

EDUC 149. 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. (Perrin)

EDUC 151. Statistical Methods in Education. (3)
(Staff)

EDUC 155. Laboratory Practices in Reading. (2-4)
Prerequisite, EDEL 153 or EDUC 157. 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. (Brigham, Sullivan, Wilson)

EDUC 157. Corrective-Remedial Reading Instruction. (3)
Prerequisite, EDEL 153 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. (Staff)

EDUC 160. 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. (Huden)

EDUC 187. Field Experience in Education. (1-4)
A. Adult Education
B. Foundations
C. Measurement and statistics
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 graduate 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. (Staff)
Note: The total number of credits which a student may earn in EDUC 187, EDUC 224, and EDUC 287 is limited to a maximum of twenty (20) semester hours.

EDUC 188. 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. Course cards must have the title of the problem and the name of the faculty member who has approved it. (Staff)

EDUC 189. 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 enterprises 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. (Staff)

For Graduates

EDUC 204. Seminar in Educational Sociology. (3)
(Staff)

EDUC 205. Comparative Education. (3)
(Lindsay, Male)

EDUC 206. Seminar in Comparative Education. (2)
(Lindsay, Male)

EDUC 207. Seminar in History and Philosophy of Education. (2)
(Staff)

EDUC 208. Analysis of Educational Concepts. (3)
(Agre)

EDUC 209. Adult Education. (3)
(Wiggin)

EDUC 211. Education in Africa. (3)
(Hopkins)

EDUC 212. Education in the Near East. (3)
(Lindsay)

EDUC 224. Apprenticeship in Education. (1-9)
A. Adult Education
B. Foundations
C. Measurement and Statistics
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 educa-

tional 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. (Staff)
Note: The total number of credits which a student may earn in EDUC 187, EDUC 224, and EDUC 287 is limited to a maximum of twenty (20) semester hours.

EDUC 230. Mediated Instructional Systems. (3)
Prerequisite, EDUC 147 and EDUC 149. Theoretical and pragmatic determinants in the selection of media systems for improving teaching-learning efficiency; development and evaluation of teaching-learning units for large-group, small-group, and self-instructional presentation; integration of print and non-print media with team teaching techniques. Review of related research. (Perrin)

EDUC 231. Practicum in Instructional Systems. (2-6)
Prerequisite, EDUC 230. Design and application of an experimental instructional system to a problem in curriculum, learning, or research. Each student will work with school or college instructors in the development, use, and evaluation of an instructional media system to solve a specific instructional problem in the field. (Wedberg)

EDUC 232. Seminar in Educational Technology Research and Theory. (2)
Prerequisite, EDUC 230. Review of the literature, including the mass media of communications as they relate to the instructional process; learning theory implications, sociological, and economics considerations as they relate to current and future mediated instructional systems. (Perrin, Wedberg)

EDUC 246. Quantitative Research Methods II. (3)
(Staff)

EDUC 251. Intermediate Statistics in Education. (3)
Prerequisite, EDUC 146 or 246 or equivalent. (Staff)

EDUC 255, 256. Advanced Laboratory Experiences in Reading Instruction. (3, 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 disablities and in recommending instructional programs for individual pupils. The second semester deals with instruction of pupils with reading disabilites. Each partcipant will plan and execute a program of instruction for an individual or a small group, applying findings of the preliminary diagnosis. (Brigham, Sullivan, Wilson)

EDUC 257. Diagnosis and Remediation of Reading Disabilities. (3)
Prerequisites, EDEL 153 and EDUC 157. 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. (Brigham, Sullivan, Wilson)

EDUC 262. Measurement in Pupil Appraisal. (3)
Prerequisite, EDUC 146. Study of group tests typically employed in school testing programs; discussion of evidence relating to the measurement of abilities. (Staff)

EDUC 265. Theory of Measurement. (2)
Prerequisites, EDUC 146-246 or EDUC 151. Treats such topics as theory and techniques used in various scaling methods, test analysis, predictive accuracy of scores, and equivalence of scores. For students desiring more advanced treatment of problems. (Giblette)

EDUC 266. Practicum in Individual Testing. (3)
Prerequisite, EDUC 262, or equivalent, and consent of instructor. Intensive study of the theory, application, and interpretation of standard measures utilizied in the individual assessment of abilities. Supervised practice in the administration of Binet, Wechsler, and other tests. (Staff)

EDUC 271. Advanced Statistics in Education. (3)
Prerequisite, EDUC 251 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. (Staff)

EDUC 272. Special Topics in Applied Statistics in Education. (1-4)
Prerequisite, EDUC 271, 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. (Staff)

EDUC 275, 276. Advanced Problems in Art Education. (3, 3)
These courses are centered about problems of teaching art in the elementary and secondary schools in terms of the philosophy of art education today, techniques and processes in the visual arts, and creative opportunities in the visual arts and in art education. The student also will have the opportunity to do special work centered about his problems in art education. (Staff)

EDUC 279. Seminar in Adult Education. (2)
(Wiggin)

EDUC 280. Research Methods and Materials. (2)
Research methodology for case studies, surveys, and experiments; measurements and statistical techniques. Primarily for advanced students and doctoral candidates.
(Rogers)

EDUC 281. Source Materials in Education. (1-2)
Bibliography development through a study of source materials in education, special fields in education, and for seminar papers and theses. (Wiggin)

EDUC 287. Internship in Education. (3-16)
A. Adult Education
B. Foundations
C. Measurement and Statistics

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 sixty 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 EDUC 187, EDUC 224, and EDUC 287 is limited to a maximum of twenty (20) semester hours. (Staff)

EDUC 288. 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 one.* (Staff)

EDUC 290. Doctoral Seminar. (1-3)
Prerequisite, passing the preliminary examinations for a doctor's degree in education, or recommendation of a doctoral adviser. Analysis of doctoral projects and theses, and of other on-going research projects. A doctoral candidate may participate in the Seminar during as many University sessions as he desires, but may earn no more than three semester hours of credit accumulated one hour at a time in the seminar. An Ed.D. candidate may earn in total no more than nine semester hours, and a Ph.D. candidate, no more than eighteen semester hours, in the Seminar and in EDUC 499. (Staff)

EDUC 399. Thesis Research. (Master's Level)
Registration required to the extent of 6 hours for master's thesis. (Staff)

EDUC 499. Dissertation Research. (Doctoral Level)
Registration required to the extent of 6-9 hours for an Ed.D. project and 12-18 hours for a Ph.D. dissertation. (Staff)

ADMINISTRATION, SUPERVISION AND CURRICULUM

For Graduates and Advanced Undergraduates

EDAD 187. Field Experience in Education. (1-4)
See EDUC 187 for description.

EDAD 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDAD 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

For Graduates

EDAD 202. The Junior College. (3)
(Kelsey)

EDAD 203. Problems in Higher Education. (3)
(Kelsey)

EDAD 210. The Organization and Administration of Public Education. (3)
The basic course in school administration. Deals with the organization and administration of school systems—at the local, state, and federal levels; and with the administrative relationships involved. (Staff)

EDAD 211. The Organization and Administration of Secondary Schools. (3)
Prerequisite EDAD 210 or 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.
(J. P. Anderson, Goldman)

EDAD 212. 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. (McLoone)

EDAD 214. 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. (van Zwoll)

EDAD 216. Public School Supervision. (3)
The nature and functions of supervision; various supervisory techniques and procedures; human relationship factors; and personal qualities for supervision.
(Dudley, J. P. Anderson, Berman)

EDAD 217. Administration and Supervision in Elementary Schools. (3)
Problems in administering elementary schools and improving instruction.
(Dudley, Bennett)

EDAD 218. School Surveys. (2-6)
Prerequisite, consent of instructor. Includes study of school surveys with emphasis on problems of school organization and administration, finance and school plant planning. Field work in school surveys is required. (Staff)

EDAD 221. Advanced School Plant Planning. (2)
EDAD 214 is a prerequisite to this course. However, students with necessary background may be admitted without completion of EDAD 214. This is an advanced course in school plant planning problems. Emphasis is given to analysis of the educational program and planning of physical facilities to accommodate that program.
(van Zwoll)

EDAD 223. 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. (Newell)

EDAD 224. Apprenticeship in Education. (1-9)
See EDUC 224 for course description.

EDAD 225. 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. (van Zwoll)

EDAD 226. Child Accounting. (2)
An inquiry into the record keeping activities of the school system, including an examination of the marking system. (van Zwoll)

EDAD 227. 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. (van Zwoll)

EDAD 234. 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.
(V. E. Anderson, Berman, Hovet)

EDAD 235. 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. (Bennett, V. Anderson, Berman)

EDAD 237. Curriculum Theory and Research. (2)
(Hovet)

EDAD 249. 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. (Staff)

EDAD 287. Internship in Education. (3-16)
See EDUC 287 for course description.

EDAD 288. Special Problems in Education. (1-6)
See EDUC 288 for course description.

EDAD 302. 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. (Kelsey)

EDAD 303. 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. (Wiggin)

EDAD 305. 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. (Kelsey and staff)

EDAD 309. Seminar in Problems of Higher Education. (2)
(Kelsey)

EDAD 399. Thesis Research. (Master's Level)
See EDUC 399 for course description.

EDAD 499. Dissertation Research. (Doctoral Level)

COUNSELING AND PERSONNEL SERVICES

For Graduates and Advanced Undergraduates

EDCP 161. Introduction to Counseling and Personnel Services. (3)
(Staff)

EDCP 165. Introduction to Rehabilitation Counseling. (3)
(Formerly EDUC 182.) (Kreiger)

EDCP 172. Mental Hygiene. (3)
(Formerly EDUC 162.) (Collins)

EDCP 187. Field Experience in Counseling and Personnel Services. (1-4)
See EDUC 187 for description.

EDCP 188. Special Problems in Counseling and Personnel Services. (1-3)
See EDUC 188 for description.

EDCP 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

EDCP 200. Introduction to Student Personnel. (2) (Formerly EDUC 228)
Prerequisite, consent of instructor. (Same as PSYC 224) 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. (Kafka)

EDCP 224. Apprenticeship in Counseling and Personnel Services. (1-9)
See EDUC 224 for description. (Staff)

EDCP 240. Pyscho-Social Aspects of Disability. (3) (Formerly EDUC 283)
Prerequisite, EDCP 165 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. (Lawrence)

EDCP 241. Student Personnel and the College Student. (2) (Formerly EDUC 304)
A demographic study of the characteristics of college students; as well as a study of their aspirations, values, and purposes. (Kafka)

EDCP 243. Occupational Choice Theory and Information. (3) (Formerly EDUC 253)
Prerequisite, EDCP 161. Research and theory related to occupational and educational decisions; school programs of related information and other activities in occupational decision. (Rhoads, Byrne)

EDCP 244, 245. Medical Aspects of Disability I, II. (3-3) (Formerly EDUC 284, 285)
Prerequisite, EDCP 165 or consent of instructor. Part of the core curriculum for rehabilitation counselors. It is designed to develop an understanding of the prognosis and complications of disease processes and disorders and a knowledge of treatment measures so that realistic vocational rehabilitation goals may be developed. (Kreiger)

EDCP 249. Personality Theories in Counseling and Personnel Services. (3)
Prerequisite, consent of instructor. Examination of constructs and research relating to major personality theories with emphasis on their significance for educators working with the behaviors of individuals in school settings. (Greenberg)

EDCP 250. Cases in Appraisal. (3)
Prerequisite, EDUC 262. Collecting and interpreting non-standardized pupil appraisal data; synthesis of all types of data through case study procedures. (Ray, Stern)

EDCP 254. Organization and Administration of Personnel Services. (2)
Prerequisite, EDCP 261 or permission of instructor. Instilling the personnel services point of view and implementing personnel services practices. (Greenberg)

EDPC 260. Counseling: Theoretical Foundations and Practice. (3)
Prerequisite, EDCP 250. Exploration of learning theories as applied to counseling in school, and practices which stem from such theories. (Byrne)

EDCP 261. Practicum in Counseling. (2-6)
Prerequisites, EDCP 260 and permission of instructor. Sequence of supervised counseling experiences of increasing complexity. Limited to eight applicants in advance. Two hours class plus laboratory. (Staff)

EDCP 263, 264. Modification of Human Behavior: Laboratory and Practicum. (3, 3)
First and second semesters. Application of methods relevant to behavior change in counseling and psychotherapy. Individual supervision and group consultation. (Magoon)

EDCP 265. Counseling in Elementary Schools. (3) (Formerly EDUC 259)
Prerequisite, EDCP 250 or consent of instructor. Counseling theory and practices as related to children. Emphasis will be placed on an awareness of the child's total behavior as well as on specific methods of communicating with the child through techniques of play interviews, observations, and the use of non-parametric data. (Collins, Greenberg)

EDCP 271. Counseling and Personnel Services Seminar. (2) (Formerly EDUC 269)
Enrollment by permission of instructor. (Hoyt, Marx)

EDCP 272. Seminar in Student Personnel. (2-6) (Formerly EDUC 310)
An intensive study of the various student personnel functions. A means to integrate the knowledges from various fields as they relate to student personnel administration. (Martin)

EDCP 273. Seminar in Rehabilitation Counseling. (2) (Formerly EDUC 286)
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. (Lawrence)

EDCP 287. Internship in Counseling and Personnel Services. (3-16)
See EDUC 287 for description.

EDCP 288. Special Problems in Counseling and Personnel Services. (1-6)
See EDUC 288 for description. (Staff)

EDCP 399. Thesis Research. (Master's Level)
See EDUC 399 for description. (Staff)

EDCP 499. Dissertation Research. (Doctoral Level)
See EDUC 499 for description. (Staff)

EARLY CHILDHOOD-ELEMENTARY EDUCATION*

For Graduates and Advanced Undergraduates

EDEL 105. Science in the Elementary School. (2-3)
A. Early Childhood. B. Elementary. Designed to help teachers acquire general science understandings, and to develop teaching materials for practical use in classrooms. Includes experiments, demonstrations, constructions, observations, field trips, and use of audio-visual materials. The emphasis is on content and method related to science units in common use in elementary schools. (Blough, Dietz, Eley, Williams)

EDEL 115. Activities and Materials in Early Childhood Education. (3)
Prerequisite, EDUC 110 (or concurrent enrollment). Storytelling; selection of books; the use, preparation, and presentation of such raw materials as clay, paint (easel and finger), blocks, wood, and scrap materials. (Stant)

*For additional courses in reading see listings under Education.

EDEL 121. Language Arts in the Elementary School. (2-3)
A. Early Childhood. B. Elementary. Teaching of spelling, handwriting, oral and written expression, and creative expression. Special emphasis given to skills having real significance to pupils. (Gantt, McCuaig, Roderick, Schumacher, Zachary)

EDEL 122. Social Studies in the Elementary School. (2-3)
A. Early Childhood. B. Elementary. Consideration given to curriculum, organization and methods of teaching, evaluation of newer materials, and utilization of environmental resources. (Gantt, O'Neill, Weaver, Duffey, Herman)

EDEL 123. The Child and the Curriculum. (2-3)
A. Early Childhood. B. Elementary. Relationship of the elementary school curriculum to child growth and development. Recent trends in curriculum organization; the effect of environment on learning; readiness to learn; and adapting curriculum content and methods to maturity levels of children. (Amershek, Schumacher)

EDEL 125. Art in Elementary School. (2)
(Lembach, Longley)

EDEL 126. Mathematics in the Elementary School. (2-3)
A. Early Childhood. B. Elementary. (Schindler, Martin, Hutchings, Ashlock)

EDEL 152. Literature for Children and Young People. (3)
(Amershek, E. Anderson, Roderick, Zachary)

EDEL 153. The Teaching of Reading. (2-3)
(Duffey, Hall, Herman, Leeper, McCuaig, Sullivan, Wilson, Zachary)

EDEL 187. Field Experience in Education. (1-4)
See EDUC 187 for description.

EDEL 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDEL 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

For Graduates

EDEL 200. Seminar in Elementary Education. (2)
Primarily for individuals who wish to write seminar papers. Prerequisite: at least 12 hours of graduate work in education. (O'Neill)

EDEL 205. Problems in Teaching Science in Elementary Schools. (3)
Prerequisite, EDEL 105 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. (Blough, Dietz, Eley, Williams)

EDEL 210. Curriculum Planning in Nursery-Kindergarten Education. (3)
An examination of significant new developments in curriculum theory and practice. (Leeper)

EDEL 211. 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. (Moyer)

EDEL 212. 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. (Leeper)

EDEL 213. Teacher-Parent Relationships. (3)
A study of the methods and materials, trends, and problems in establishing close home-school relationships. (Staff)

EDEL 214. 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. (Moyer)

EDEL 221. Problems of Teaching Language Arts in Elementary Schools. (3)
Prerequisite, EDEL 121 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. (McCuaig, Roderick, Schumacher, Zachary)

EDEL 222. Problems of Teaching Social Studies in Elementary Schools. (3)
Prerequisite, EDEL 122 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. (Duffey, Gantt, O'Neill, Weaver)

EDEL 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description.

EDEL 226. Problems of Teaching Mathematics in Elementary Schools. (3)
Prerequisite, EDEL 126 or approval of instructor. Critical examination of selected theory and research in the teaching of mathematics in elementary schools. Evaluation of instructional materials. Implications for practice.
(Ashlock, Hutchings, Schindler)

EDEL 227. Diagnosis and Remediation of Arithmetic Disabilities. (3)
Prerequisite, EDEL 126 and EDUC 150 or equivalent. For those who wish to increase competency in diagnosing and correcting arithmetic disabilities. Concerned with classroom and clinical techniques, instructional materials, and remedial procedures useful to the teacher or clinician in (1) diagnosing serious arithmetic difficulties and (2) planning programs of individual and small-group remediation. The work includes the writing of diagnostic and progress reports. (Ashlock)

EDEL 253. 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 development reading instruction, with special emphasis on persistent problems.
(Hall, McCuaig, Sullivan, Wilson, Zachary)

EDEL 287. Internship in Education. (3-16)
See EDUC 287 for description.

EDEL 288. Special Problems in Education. (1-6)
See EDUC 288 for description.

EDEL 399. Thesis Research. (Master's Level)
See EDUC 399 for description.

EDEL 499. Dissertation Research. (Doctoral Level)

HUMAN DEVELOPMENT EDUCATION

For Graduates and Advanced Undergraduates

EDHD 102, 103, 104. Child Development Laboratory I, II and III. (2, 2, 2)
These courses involve the direct study of children throughout the school year. Each participant gathers a wide body of information about an individual, presents the accumulating data from time to time to the study group for criticism and group analysis and writes an interpretation of the dynamics underlying the child's learning, behavior and development. Provides opportunity for teachers in-service to earn credit for participation in their own local child study group.

EDHD 105. Adolescent Development. (3)
This course cannot be used to meet the psychological foundation requirements for teacher certification. (Gardner)

EDHD 108. 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 at home, in school, and in other settings.

EDHD 112, 114. Scientific Concepts in Human Development I and II. (3, 3)
Summer session.

EDHD 113, 115. Laboratory in Behavior Analysis I and II. (3, 3)
Summer session.

EDHD 116. Scientific Concepts in Human Development III. (3)
Guided reading and observation of pupils throughout the school year. Emphasis on human development concepts relating to the 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 102, 103.)

EDHD 117. Laboratory in Behavior Analysis III. (3)
Prerequisite, EDHD 116. Guided reading and observation of pupils throughout the school year. Emphasis on analysis of intrinsic aspects of learning and behavior including cognitive processes, motivation, self-concept, attitudes, and values. For in-service educators. (Not open to persons with credit in EDHD 102, 103.)

EDHD 120, 121, 122. Study of Human Development and Learning in School Settings I, II, III. (2, 2, 2)
A sequence of courses which enables in-service teachers and administrators to carry on 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. (Staff)

EDHD 145. Guidance of Young Children. (3)
(Dittmann)

EDHD 160. Educational Psychology. (3)
Prerequisites, PSYCH 001 or EDUC 110 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 110 by regularly matriculated students in the teacher education program. (Milhollan)

EDHD 187. Field Experience in Education. (1-4)
See EDUC 187 for description.

EDHD 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDHD 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

For Graduates

EDHD 200. 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.
(Hamby, Kurtz, Kyle, Thompson)

EDHD 201. Biological Bases of Behavior. (3)
EDHD 200 or its equivalent must be taken before EDHD 201 or concurrently. Emphasizes that understanding human life, growth and behavior depends on understanding the ways in which the body is able to capture, control and expend energy. Application thoughout is made to human body processes and implications for understanding and working with people. (Chapin)

EDHD 202. Social Bases of Behavior. (3)
EDHD 200 or its equivalent must be taken before EDHD 202 or concurrently. Analyzes the socially inherited and transmitted patterns of pressures, expectations and limitations learned by an individual as he grows up. These are considered in relation to the patterns of feeling and behaving which emerge as the result of growing up in one's social group. (Rogolsky)

EDHD 203. Integrative Bases of Behavior. (3)
EDHD 200, or its equivalent. EDHD 201 and EDHD 202 are prerequisite. Analyzes the organized and integrated pattern of feeling, thinking and behaving which emerge from the interaction of basic biological drives and potentials with one's unique experience growing up in a social group. (Green)

EDHD 204, 205. Physical Processes in Human Development. (3, 3)
Prerequisite, EDHD 200 or equivalent. Describes in some detail the major organic processes of conception, biological inheritance; differentiation and growth of the body; capture, transportation and use of energy; perception of the environment; coordination and integration of function; adaptation to unusual demands and to frustration; normal individual variation in each of the above processes. (Chapin)

EDHD 206, 207. Socialization Processes in Human Development I, II. (3, 3)
Prerequisite, EDHD 200 or equivalent. Analyzes the processes by which human beings internalize the culture of the society in which they live. The major subcultures in the United States, their training procedures, and their characteristic human expressions in

folk-knowledge, habits, attitudes, values, life-goals, and adjustment patterns are analyzed. Other cultures are examined to highlight the American way of life and to reveal its strengths and weaknesses. (Kyle, Kurtz, Matteson, Mershon)

EDHD 208, 209. Self Processes in Human Development I and II. (3, 3)
Prerequisite, EDHD 200 or equivalent. Analyzes the effects of the various physical and growth processes, affectional relationships, socialization processes, and peer group roles and status on the integration, development, adjustment, and realization of the individual self. This analysis includes consideration of the nature of intelligence and of the learning process; the development of skills, concepts, generalizations, symbolizations, reasoning and imagination, attitudes, values, goals and purposes; and the conditions, relationships and experiences that are essential to full human development. The more common adjustment problems experienced in our society at various maturity levels, and the adjustment mechanisms used to meet them are studied.
(Bowie, Goering, Mershon, Rogolsky)

EDHD 210. Affectional Relationships and Processes in Human Development. (3)
EDHD 200 or its equivalent must be taken before or concurrently. Describes the normal development, expression and influence of love in infancy, childhood, adolescence and adulthood. It deals with the influence of parent-child relationship involving normal acceptance, neglect, rejection, inconsistency, and over-protection upon health, learning, emotional behavior and personality adjustment and development. (Hatfield)

EDHD 211. Peer-Culture and Group Processes in Human Development. (3)
EDHD 200 or its equivalent must be taken before or concurrently. Analyzes the process of group formation, role-taking and status-winning. It describes the emergence of the "peer-culture" during childhood and the evolution of the child society at different maturity levels to adulthood. It analyzes the developmental tasks and adjustment problems associated with winning, belonging, and playing roles in the peer group.
(Hatfield)

EDHD 212, 214, 216. Advanced Scientific Concepts in Human Development I, II, III. (3, 3, 3)
Summer session.

EDHD 213, 215, 217. Advanced Laboratory in Behavior Analysis I, II, III. 3, 3, 3)
Summer session.

EDHD 221. Learning Theory and the Educative Process I. (3)
Provides a systematic review of the major theories and their impact on education. Considers factors that influence learning. (Bolea, Eliot, Milhollan, Perkins)

EDHD 222. Learning Theory and the Educative Process II. (3)
Prerequisite, EDUC 110 or equivalent. Provides an exploration in depth of current theoretical and research developments in the field of human learning, especially as related to educational processes. Considers factors that influence learning.
(Eliot, Perkins)

EDHD 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description.

EDHD 230, 231. Field Program in Child Study I and II. (2-6)
Prerequisite, consent of instructor. Offers apprenticeship training preparing properly qualified persons to become staff members in human development workshops, consultants to child study field programs and coordination of municipal or regional child study programs for teachers or parents. Extensive field experience is provided. In gen-

eral this training is open only to persons who have passed their preliminary examinations for the doctorate with a major in human development or psychology.
(Kurtz, Thompson)

EDHD 250a, 250b, 250c. Direct Study of Children. (1, 1, 1)
May not be taken concurrently with EDHD 102, 103, or 104. 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 taken concurrently with such courses. Teachers active in their jobs while taking advanced courses in human development may use records from their own classrooms for this course. A minimum of one year of direct observation of human behavior is required of all human development students at the master's level. This requirement may be satisfied by this course. (Morgan)

EDHD 260. Synthesis of Human Development Concepts. (3)
Prerequisites, EDHD 204, 206 and 208. A seminar wherein advanced students work toward a personal synthesis of their own concepts in human growth and development. Emphasis is placed on seeing the dynamic interrelations between all processes in the behavior and development of an individual. (Morgan)

EDHD 270. Seminars in Special Topics in Human Development. (2-6)
Prerequisite, consent of the instructor. (Bolea, Huebner, Goering, Perkins)

EDHD 287. Internship in Education. (3-16)
See EDUC 287 for description.

EDHD 288. Special Problems in Education. (1-6)
See EDUC 288 for description.

EDHD 399. Research—Thesis. (Master's Level)
See EDUC 399 for description.

EDHD 499. Research—Thesis. (Doctoral Level)

INDUSTRIAL EDUCATION

For Graduates and Advanced Undergraduates

EDIN 115. Research and Experimentation in Industrial Arts. (3)
(Maley)

EDIN 121. Industrial Arts in Special Education. (3)
Four hours laboratory per week, one hour lecture. Prerequisite, EDSP 170 and 171 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's major interest in special education.
(Gattle)

EDIN 125, 126. Industrial Training in Industry I, II. (3, 3)
The first course is designed to provide an overview of the function of industrial training, type of programs, organization, development and evaluation. The second course (prerequisite the first course) is designed to study specific training programs in a variety of industries, plan program visitation, training program development, and analyses of industrial training research. (Willard)

EDIN 143. Industrial Safety Education I. (2)
(Crosby, Smith, White)

EDIN 144. Industrial Safety Education II. (2)
In this course exemplary safety practices are studied through conference discussions, group demonstrations, and organized plant visits to selected industrial situations. Methods of fire precautions and safety practices are emphasized. Evaluative criteria in safety programs are formulated. (Crosby, Smith, White)

EDIN 150. Training Aids Development. (3)
(Beatty, Gettle, Maley)

EDIN 157. Tests and Measurements. (3)
(Luetkemeyer, Mietus, Stough)

EDIN 161. Principles of Vocational Guidance. (2)
(Mietus)

EDIN 164. Laboratory Organization and Management. (3)
(Mietus, Beatty)

EDIN 165. Modern Industry. (3)
(Harrison, Chambliss)

EDIN 166. Educational Foundations of Industrial Arts. (2)
(Anderson, Beatty)

EDIN 167. Problems in Occupational Education. (3)
(Anderson, Chambliss)

EDIN 169. Occupational Analysis and Course Construction. (3)
(Chambliss)

EDIN 171. History and Principles of Vocational Education. (3)
(Luetkemeyer, Tierney)

EDIN 175. Recent Technological Developments in Products and Processes. (3)
(Crosby, Mietus)

EDIN 187. Field Experience in Education. (1-4)
See EDUC 187 for description.

EDIN 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDIN 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

For Graduates

EDIN 207. Philosophy of Industrial Arts Education. (3)
(Harrison)

EDIN 214. School Shop Planning and Equipment Selection. (3)
(Tierney)

EDIN 216. Supervision of Industrial Arts. (2)
(Tierney)

EDIN 220. Organization, Administration, and Supervision of Vocational Education. (2)
(Chambliss)

EDIN 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description. (Staff)

EDIN 240. Research in Industrial Arts and Vocational Education. (2)
This is a course offered by arrangement for persons who are conducting research in the areas of industrial arts and vocational education. (Staff)

EDIN 241. 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. (Maley)

EDIN 242. Coordination in Work-Experience Programs. (2)
Surveys and evaluates the qualifications and duties of a teacher-coordinator in a work-experience program. Deals particularly with evolving patterns in city and country schools in Maryland, and is designed to help teacher-coordinators, guidance counselors, and others in the supervisory and administrative personnel concerned with functioning relationships of part-time cooperative education in a comprehensive educational program. (Chambliss)

EDIN 248. Seminar in Industrial Arts and Vocational Education. (2)
(Staff)

EDIN 250. 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.
(Harrison, Luetkemeyer)

EDIN 287. Internship in Education. (3-16)
See EDUC 287 for description.

EDIN 288. Special Problems in Education. (1-6)
See EDUC 288 for description.

EDIN 399. Thesis Research. (Master's Level)
See EDUC 288 for description.

EDIN 499. Dissertation Research. (Doctoral Level)

SECONDARY EDUCATION

For Graduates and Advanced Undergraduates

EDSE 101. Problems in Teaching Office Skills. (3)
(Peters)

EDSE 102. Methods and Materials in Teaching Bookkeeping and Related Subjects. (3)
(Peters)

EDSE 104. Basic Business Education in the Secondary Schools. (3)
(Peters)

EDSE 114, 115. Financial and Economic Education. (3, 3)
Materials, resources and methods of teaching personal finances and economics in the public schools. Special attention will be directed toward the problems of teaching the consumer's role in relation to his earnings and spending power, and the need for intelligent planning and handling of personal and family resources. (C. R. Anderson)

EDSE 120. Organization and Coordination of Distributive Education Programs. (3)
(Anderson)

EDSE 121. Methods and Materials in Distributive Education. (3)
(Anderson)

EDSE 123. Field Experiences; Distribution. (3)
First and second semester and summer session. Supervised work experiences in a distributive occupation to apply theory of distribution to the function of distribution as a basis for vocational teaching and guidance. By individual arrangement with the advisor. (Anderson)

EDSE 125. Problems in Teaching Home Economics. (3)
(Brabble, Lemmon)

EDSE 126. Evaluation of Home Economics. (3)
(Brabble, Lemmon)

EDSE 130. The Junior High School. (2-3)
(McClure, Grambs)

EDSE 134. Materials and Procedures for the Secondary School Core Curriculum. (3)
This course is designed to bring practical suggestions to teachers who are in charge of core classes in junior and senior high schools. Materials and teaching procedures for specific units of work are stressed. (Grambs)

EDSE 139. Speech Methods and Resources in Secondary Schools. (3)
Practical suggestions for developing curricular and extra-curricular speech programs. Planning units and courses of study, current trends, and aims of speech education, use of printed and audio-visual materials, evaluating of performance directed speech activities, and the teaching of listening. (Wolvin)

EDSE 142. Teaching the Audio-Lingual Skills in Foreign Languages (3)
Graduate credit allowed by special arrangement and adviser approval. Designed for high school teachers. Methods in making and using tape recordings, using electronic laboratories, developing oral-aural skills and direct approach to language teaching are emphasized. (Flores)

EDSE 187. Field Experience in Education. (1-4)
See EDUC 189 for description.

EDSE 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDSE 189. Workshops. Clinics, Institutes. (1-6)
See EDUC 189 for description.

For Graduates

EDSE 200. Administration and Supervision of Business Education. (3)
Major emphasis on departmental organization and its role in the school program, curriculum, equipment, budget-making, supervision, guidance, placement and follow-up, school-community relationships, qualifications and selection of teaching staff, visual aids, and in-service programs for teacher development. For administrators, supervisors, and teachers. (Peters)

EDSE 205. Seminar in Business Education. (2)
(Peters)

EDSE 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description.

EDSE 239. Seminar in Secondary Education. (2)
(Adkins, McClure, Risinger)

EDSE 240. Trends in Secondary School Curriculum. (3)
A. English B. Foreign Language C. Mathematics D. Science E. Social Studies F. Speech G. General H. Home Economics Education I. Music J. Art. Recent developments in educational thinking and practice which have affected the curriculum in one of the specified academic areas. (Staff)

EDSE 243. Theory and Research in Secondary Education. (1-3)
A. English B. Foreign Language C. Mathematics D. Science E. Social Studies F. Speech G. General H. Business I. Distributive Education J. Home Economics K. Art L. Reading M. Music.
A survey of the research literature in the specified area; evaluation of research techniques relative to subject area; consideration of relevant instructional curriculum theory; evaluation of modern teaching methods and techniques as they apply to the specific area. One to three semester hours with a maximum of nine.

EDSE 247. Seminar in Special Subject Areas. (2)
A. English B. Foreign Languages C. Mathematics D. Science E. Social Studies F. Speech G. Business Education H. Home Economics I. Art J. Reading K. Music.

EDSE 253 Problems in the Teaching of Reading in the Secondary School (3)
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 255. 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. (Peters)

EDSE 256. Curriculum Development in Business Education. (2-3)
This course is especially designed for graduate students interested in devoting the summer session to 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 curriulum research and organization of appropriate course content.
(Peters)

EDSE 260. Seminar in Home Economics Education. (2)
(Green, Lemmon)

EDSE 261. Trends in the Teaching and Supervision of Home Economics. (2-4)
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. (Green, Lemmon)

EDSE 287. Internship in Education. (3-16)
See EDUC 287 for description.

EDSE 288. Special Problems in Education. (1-6)
See EDUC 288 for description.

EDSE 399. Thesis Research. (Master's Level)
See EDUC 399 for description.

EDSE 499. Dissertation Research. (Doctoral Level)

MUSIC EDUCATION

For Graduates and Advanced Undergraduates

EDMU 116. Music in Early Childhood Education (3)
First and second semesters. Prerequisite, MUSC 016 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. (Shelley)

EDMU 125. 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. (Shelley)

EDMU 128. Music for the Elementary Classroom Teacher. (2-3)
Prequisite, MUSC 016 or consent of instructor. For non-music majors. Methods for guiding elementary school students in musical experiences; development of objectives and a survey of instructional materials. (Staff)

EDMU 129. Methods and Materials for Class Instrumental Instruction. (2)
Prerequisite, previous or concurrent registration in MUSC 061-068. Two one-hour laboratories and one lecture per week. Teaching techniques and rehearsal techniques for beginning and intermediate instrumental classes—winds, strings, and percussion. (Gallagher, Taylor)

EDMU 132. Music in Secondary Schools. (2-3)
Prerequisite, consent of instructor. A study of the music program in the junior and senior high school with emphasis on objectives, organization of subject matter, teaching techniques and materials for general music classes. (Blum, Shelley)

EDMU 139. Music for the Elementary School Specialist. (2-3)
Prerequisite, consent of instructor. Teaching techniques and instructional materials for the music program in the elementary schools. For the music specialist. (Staff)

EDMU 155. Organization and Technique of Instrumental Class Instruction. (3)
Prerequisite, consent of instructor. Practical instruction in the methods of tone production, tuning, fingering and in the care of woodwind and brass instruments. A survey of the materials and published methods for class instruction. (Staff)

EDMU 163. Band and Orchestra Techniques and Administration. (2-3)
Prerequisites, MUSC 061-068 and 161. Comprehensive study of instructional materials, rehearsal techniques, program planning, and band pageantry for the high school instrumental program. Organization, scheduling, budgeting and purchasing are included. (Gallagher, Taylor)

EDMU 170. Methods and Materials for Class Piano Instruction. (2)
Objective techniques and materials for teaching class piano. Special emphasis is placed on analysis of materials, audio-visual aids, use of electronic pianos and equipment. (deVermond)

EDMU 173. 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. (Blum)

EDMU 175. Methods and Materials in Vocal Music for Secondary Schools. (2-4)
Prerequisite, consent of instructor. A survey of repertoire and methods for teaching choral groups and voice classes. Diction, interpretation, tone production, intonation, phrasing, rehearsal techniques and style characteristics. (Grentzer, Shelley)

EDMU 176. Special Problems in the Teaching of Instrumental Music. (2-3)
Prerequisite, MUSC 061-068 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 three groups of instruments (strings, woodwind, or brass-percussion) will be studied each time the course is offered. (Staff)

EDMU 180. Instrumental Music for Secondary Schools. (2)
Prerequisite, consent of instructor. A survey of the repertoires for high school orchestra, band, and small ensemble. Problems of interpretation, intonation, tone quality, and rehearsal techniques. The course may be repeated for credit, since different repertoires are covered each time the course is offered. (Staff)

For Graduates

EDMU 200. 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. (Grentzer)

EDMU 201. 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. (Grentzer)

EDMU 202. Foundations of Music Education. (3)
Educational thought and its application to instruction and evaluation in music education. (Taylor)

EDMU 205. 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. (Blum, Grentzer)

EDMU 207. 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. (Blum, Grentzer)

EDMU 208. The Teaching of Music Appreciation. (3)
A study of the objectives for the elementary and secondary levels; the techniques of directed listening, the presentation of theoretical and biographical materials, course planning, selection and use of audio-visual aids and library materials, and the correlation between music and other arts. (Ulrich)

EDMU 209. 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. (Taylor)

EDMU 210. Advanced Orchestration and Band Arranging. (3)
Prerequisite, MUSC 147 or the equivalent, or consent of the 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. (Trimble)

EDMU 250. History of Music Education in the United States. (3)
Prerequisite, permission of the instructor. The study of historical development of pedagogical practices in music education, their philosophical implications and educational values. (Grentzer, Taylor)

EDMU 204. Current Trends in Music Education. (3)
A survey of current philosophies and objectives of music in the elementary, secondary schools, and teacher training programs. The influence of educational and social changes upon these programs. May be repeated once for credit after four years.
(deVermond, Grentzer)

SPECIAL EDUCATION

For Advanced Undergraduates and Graduates

EDSP 170. Introduction to Special Education. (3)
Designed to give an understanding of the needs of all types of exceptional children, stressing preventive and remedial measures. (Staff)

EDSP 171. Characteristics of Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. C. Perceptually impaired. Prerequisite, EDSP 170.
(Staff)

EDSP 172. Education of Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. C. Perceptually impaired. Prerequisite EDSP 171 or equivalent. (Staff)

EDSP 173. Curriculum for Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. Prerequisite, EDSP 171 or equivalent. (Staff)

EDSP 175. Education of the Slow Learner. (3)
(Staff)

EDSP 187. Field Experience in Education. (1-4)
See EDUC 187 for description. (Staff)

EDSP 188. Special Problems in Education. (1-3)
See EDUC 188 for description. (Staff)

EDSP 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description. (Staff)

For Graduates

EDSP 200. Exceptional Children and Youth. (3)
Prerequisite, consent of instructor. Deals primarily with research relevant to the intellectual, psychological, physical, and emotional characteristics of exceptional children. (Staff)

EDSP 201. Emotionally Handicapped Children and Youth. (3)
Prerequisite, EDSP 200 and consent of instructor. Deals with epidemeology, etiology, classification, diagnostic procedures, behavioral characteristics, treatment and prevention of child and adolescent disturbances. (Staff)

EDSP 205. The Exceptional Child and Society. (3)
Prerequisite, EDSP 200 or consent of instructor. Relationship of the role and adjustment of the child with an exceptionality to societal characteristics. (Staff)

EDSP 210. Administration and Supervision of Special Education Programs. (3)
Prerequisite, consent of instructor. Consideration of the determination, establishment and function of educational programs to exceptional children for administrative and supervisory personnel. (Staff)

EDSP 215. Evaluation and Measurement of Exceptional Children and Youth. (3)
Prerequisites, EDUC 150, EDUC 151, EDSP 200. Deals with the understanding and interpretation of the results of psychological and educational tests applicable for use with exceptional children. (Staff)

EDSP 220. Educational Diagnosis and Planning for Exceptional Children and Youth. (3)
Prerequisite, EDSP 215. Deals with the identification of learning characteristics of exceptional children and the planning of appropriate programs. (Staff)

EDSP 221. Psycho-Educational Programming with Emotionally Handicapped Children and Youth. (3)
Prerequisite, EDSP 200. Special Education 201 and consent of instructor. Deals with factors pertinent to therapeutic education of disturbed children and adolescents in special treatment settings. (Staff)

EDSP 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description. (Staff)

EDSP 225. Problems in the Education of the Mentally Retarded. (3)
Prerequisite, 9 hours EDSP including EDSP 200, or consent of instructor. Considera-ation of the pertinent psychological, educational, medical, sociological and other research and theoretical material relevant to the determination of trends, practices, regarding the mentally retarded. (Staff)

EDSP 230. Problems in the Education of the Gifted. (3)
Prerequisite, 9 hours EDSP including EDSP 200, 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. (Staff)

EDSP 235. Problems in the Education of Children with Emotional Disturbances. (3)
Prerequisite, 9 hours EDSP including EDSP 200, 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, rgarding the emotionally disturbed. (Staff)

EDSP 240. Problems in the Education of Children with Perceptual Impairment. (3)
Prerequisite, 6 hours in Education of the Perceptually Impaired, EDSP 215, and EDSP 220 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. (Staff)

EDSP 278. Seminar in Special Education. (2)
Prerequisite, 9 hours in EDSP, or consent of instructor. (Staff)

EDSP 287. Internship in Education. (3-16)
See EDUC 287 for description. (Staff)

EDSP 288. Special Problems in Education. (1-6)
See EDUC 288 for description. (Staff)

EDSP 399. Thesis Research. (Master's Level)
See EDUC 399 for description. (Staff)

EDSP 499. Dissertation Research. (Doctoral Level)
(Staff)

ELECTRICAL ENGINEERING

Professor and Head: DeClaris.

Professors: Chu, Lin, Newcomb, Popov, Price, Reiser, Rutelli, Shekel, Taylor, Wagner, Weiss.

Associate Professors: Abrams, Basham, Emad, Harger, Harmuth, Hochuli, Kim, Marcovitz, Pugsley, Rao, Simons, Torres, Tretter.

Research Associate: Abraham.

Assistant Professors: Choudhury, Dooley, Friedman, Larson, Lee, Levine, Levine, Lieberman, Opacic, Pinkston, Pryor Ramanujacharyulu, Rhee, Robinson, Rumbaugh, Siahatgar, Zajac, Zaki.

Lecturers: Colburn, Fordham, Morakis, Schulman.

Instructors: Glock, Littlepage.

The Electrical Engineering Department offers graduate work leading to the Master of Science and the Doctor of Philosophy degrees with specialization in: (a) biomedical engineering, (b) circuits, (c) communication and control, (d) computers, and (e) electrophysics. Courses in these areas are listed below. An individual study program is planned for each graduate student which includes an appropriate sequence of courses and a required thesis. Opportunities for research, design and thesis work are available in:

Biomedical Engineering

Includes electrophysiology, modeling of neural activity, automated diagnostics, and medical electronics.

Circuits

Includes graph theory, matrix and tensor methods, applied analysis as well as synthesis, computer-aided design, integrated circuits, and microsystems.

Communication and Control

Includes coding theory and applications, optimal control, optical communications, radar systems, digital communications, and Walsh function applications.

Computers

Includes switching theory, arithmetic coding and self-checking processes, automata theory, digital, analog and hybrid systems for general and special purpose machines, graphics, and time-sharing systems.

Electrophysics

Includes electronmagnetic theory in stochastic media, plasma propagation, charged particle dynamics and accelerator design, laser technology, non-linear optics, materials and processes for integrated circuits and solid state devices.

A booklet which contains detailed information concerning admission to graduate study, the requirements for the master's and doctoral degrees, the qualifying examinations, graduate student support opportunities, and other related matters may be obtained in person from or by writing to, the Office of Graduate Studies, Electrical Engineering Department.

BIOMEDICAL

For Graduates and Advanced Undergraduates

ENEE 144. Electronic Circuits. (4)
Prerequisite, ENEE 060 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 electronic circuits. Credit not normally given for this course in an electrical engineering major program. (ENEE 123 or 125 may optionally be taken as an associated laboratory, as is appropriate). 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. (Staff)

ENEE 146. 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. (Staff)

ENEE 148. Electronic Instrumentation for Physical Science. (3)
Two hours of lecture and two hours of laboratory per week. Prerequisite, ENEE 060 or 120, Physics 104 or equivalent, or consent of the 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. (Staff)

For Graduates

ENEE 245. Electrical Techniques in Medicine and Biology. (3)
Prerequisite, Mathematics through differential equations and physics through electricity and magnetism, or equivalent. Electrical properties of biological tissues and cell suspensions, alternating current impedence, spectroscopy, transducers and related instrumentation systems for biological measurements, biological control systems, interaction of electromagnetic fields with biological systems. Special topics in biomedical engineering are presented under the seminar course ENEE 222 and the advanced topics course ENEE 223. (DeClaris)

CIRCUITS

For Graduates and Advanced Undergraduates

*ENEE 120. Circuit Analysis II. (4)
(See ENEE 121 for related laboratory course). Prerequisite, ENEE 90 Co-requisites, ENEE 121, Math 66. Required of juniors in Electrical Engineering. Continuation of ENEE 90. Complex Frequency and Frequency Response, application of both frequency domain and time-domain concepts, mutual inductance and transformers, polyphase and time Fourier and Laplace transform methods, driving point and transfer function, controlled sources. (Levine)

*ENEE 121. Circuit Laboratory II. (1)
Two hours of laboratory per week. Co-requisite, ENEE 120. Required of juniors in Electrical Engineering. Laboratory to be taken in association with ENEE 120. Steady-State and transient circuit measurements, frequency response. (Staff)

*ENEE 122. Electronic Circuits I. (4)
(See ENEE 123 for related laboratory course). Prerequisite, ENEE 120. Co-requisites, ENEE 123, and ENEE 130. Required of juniors in Electrical Engineering. Transistors and electron tubes in DC, pulse, and small-signal situations, analysis of basic amplifiers, biasing, basic electronic switches, tuned and wide-band amplifiers, feedback. ENEE 124 continues where ENEE 122 ends. (Glock)

*ENEE 123. Electronics Laboratory I. (1)
Two hours of laboratory per week. Co-requisite, ENEE 122. Required of juniors in Electrical Engineering. Laboratory to be taken in association with ENEE 122. Transistor and vacuum-tube characteristics, basic electronic switches, amplifiers, design practice. To the extent possible, work will be individual or in two-man squads. (Staff)

*ENEE 124. Electronic Circuits II. (4)
(See ENEE 125 for related laboratory course). Prerequisite, ENEE 122. Co-requisites, ENEE 132, ENEE 123, and ENEE 125. Required of seniors in Electrical Engineering. Continuation of ENEE 122. Electron tubes and transistors in continuous-wave and pulse applications. Class C amplifiers, modulation and detection; pulse generation, delay, and storage, feedback amplifiers. (Simons)

*ENEE 125. Electronics Laboratory II. (1)
Two hours of laboratory per week. Co-requisite, ENEE 124. Required of seniors in Electrical Engineering. Laboratory to be taken in association with ENEE 124. Specification and design of electronic circuits. Students work as individuals or as responsible members of a project team. (Staff)

*Graduate credit is not given for E.E. majors.

ENEE 150. Network Synthesis. (3)
Prerequisite, ENEE 120. Positive real functions, synthesis or driving-point impedances, network functions, approximation methods, Chebyshev and Butterworth filters. (Basham)

ENEE 172. Advanced Pulse Techniques. (3)
(See ENEE 173 for related laboratory course). Prerequisite, ENEE 124 or ENEE 144 or equivalent. Bistable, monostable, and astable circuits, sweep circuits, synchronization, counting, gates, comparators, magnetic core circuits, semi-conductor and vacuum-tube circuits. (Schulman)

ENEE 173. Pulse Techniques Laboratory. (1)
Two hours of laboratory per week. Co-requisite, ENEE 172, or ENEE 164 and permission of the instructor. Experiments on switching circuits, bistable, monostable and astable circuits, sweep circuits, gates, comparators. (Staff)

ENEE 174. Advanced Radio Engineering. (3)
Co-requisite, ENEE 124. (See ENEE 175 for related laboratory course). The coupling coefficient concept, high-frequency effects, design and optimization of amplifiers, stability considerations, gain limitations, noise figure, design of harmonic generators, design of stable oscillators. (Simons)

ENEE 175. Advanced Radio Engineering Laboratory. (1)
Two hours of laboratory per week. Co-requisite, ENEE 174. Experiments on multiple tuned amplifiers, noise figure measurements, class-C amplifiers, varactors, modulators. Projects. (Staff)

ENEE 190. Mathematical Foundations of Circuit Theory. (3)
Prerequisites, ENEE 120 and MATH 22, or equivalent. Review of determinants, linear equations, matrix theory, eigenvalues, theory of complex variables, inverse Laplace transforms. Applications are drawn primarily from circuit analysis. (Newcomb)

For Graduates

ENEE 202. Transients in Linear Systems I. (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. (Wagner)

ENEE 203. Transients in Linear Systems II. (3)
Prerequisite, Undergraduate major in Electrical or Mechanical Engineering or Physics. Continuation of ENEE 202. (Wagner)

ENEE 204. Advanced Electronic Circuit Design. (3)
Prerequisite, ENEE 124 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. (Wagner)

ENEE 230. Mathematics of Circuit Analysis. (3)
Prerequisite, undergraduate circuit theory and advanced calculus. Determinants, linear equations, matrix theory, eigenvalues, theory of complex variable inverse Laplace transforms, applications to circuit analysis. (DeClaris)

ENEE 231. Active Network Analysis. (3)
Prerequisite, ENEE 190 or equivalent. The complex frequency plane, conventional feedback amplifier theory, mathematical definitions of feedback and sensitivity,

theorems for feedback circuits, stability and physical realizability of electrical networks, Nyquist's and Routh's criteria for stability, activity and passivity criteria. (Newcomb)

ENEE 232. Network Synthesis I. (3)
Prerequisite, ENEE 234 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. (Basham)

ENEE 233. Network Synthesis II. (3)
Prerequisite, ENEE 234 or equivalent. Continuation of ENEE 232. (Rumbaugh)

ENEE 234. Graph Theory and Network Analysis. (3)
Prerequisite, ENEE 230. 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-port networks. (DeClaris)

ENEE 235. Applications of Tensor Analysis. (3)
Prerequisite, ENEE 202 or ENEE 230. 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. (Wagner)

ENEE 284. Semiconductor Device Models. (3)
Prerequisite, ENEE 182 and ENEE 234, or equivalents. Single-frequency models for transistors; small-signal and wide-band models for general nonreciprocal 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. (Lin)

COMMUNICATION AND CONTROL

For Graduates and Advanced Undergraduates

*ENEE 142. Engineering Probability. (2)
Prerequisites, Math 22 and ENEE 90. Required of electrical engineering majors. Probability theory, discrete and continuous, statistical distribution functions and their parameters, applications to electrical engineering. (Dooley)

ENEE 154. Feedback Control Systems. (3)
Prerequisites, Math 66 and ENEE 122. (See ENEE 155 for related laboratory course). Feedback system operation and design, stability criteria, basic design techniques, correlation of time and frequency-domain concepts, flow-graph algebra, system synthesis to a variety of specifications. (Choudhury)

ENEE 155. Feedback Control Systems Laboratory. (3)
Two hours of laboratory per week. Co-requisite, ENEE 154. Projects to enhance the student's understanding of feedback control systems and familiarize him with some of the devices used in the control field. (Larson)

ENEE 156. Communication Theory. (3)
Prerequisite, ENEE 142. Random signals: elements of random processes, noise, Gaussian process, correlation function and power spectra, linear operations; optimum receivers: vector and waveform channels, receiver implementation, probability of error per-

*Graduate credit not given to Electrical Engineering majors

formance; efficient signaling: sources, encoding, dimensionality, channel capacity; waveform communication: linear, angle, and pulse modulation. (Tretter)

ENEE 157. Introduction to Information Theory. (3)
Prerequisite, ENEE 142. 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. (Pinkston)

ENEE 158. Signal Analysis, Modulation and Noise. (3)
Prerequisites, ENEE 122 and ENEE 142. Signal transmission through networks, transmission in the presence of noise, statistical methods of determining error and transmission effects, modulation schemes. (Dooley)

For Graduates

ENEE 212. Control Systems Analysis and Synthesis. (3)
Prerequisite, Undergraduate automatic control theory background. Linear control systems analysis and synthesis using time and frequency domain techniques; flow graphs, error coefficients, sensitivity, stability, compensation to meet specifications, introduction to sampled data systems. (Same as ENME 212.) (Emad)

ENEE 213. Nonlinear Control Systems. (3)
Prerequisite, ENEE/ENME 212 or equivalent. Approximate analysis of nonlinear systems using series, perturbations, and linearization; introduction to state space formulation of differential equations, systems with stochastic inputs; stability, introduction to optimum switched systems, adaptive control systems. (Same as ENME 213.) (Emad)

ENEE 218. Signal Analysis and Noise I. (3)
Prerequisite, Equivalent to ENEE 158. Mathematical description of noise, spectral analysis, noisy signal detection, optimum linear systems. (Dooley)

ENEE 219. Signal Analysis and Noise II. (3)
Prerequisite, ENEE 218. Continuation of ENEE 218. (Harger)

ENEE 220. Statistical Communication Theory. (3)
Prerequisite, ENEE 219. Statistical description of signals, testing statistical hypotheses, likelihood testing, statistical estimation of signal parameters. (Harger)

ENEE 221. Information Theory. (3)
Prerequisite, STAT 100 or equivalent. Information measure; channels; source encoding; error-correcting codes. (Tretter)

ENEE 224. Error Correcting Codes. (3)
Prerequisite, ENEE 221. Algebraic burst and random error correcting codes, convolutional encoding and sequential decoding, threshold decoding, concatenated codes, P-N sequences, arithmetic codes. (Tretter)

ENEE 225. Introduction to Radar Signals and Systems. (3)
Co-requisite, ENEE 218. 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. (Harger)

ENEE 226. Radar Signals and Systems. (3)
Prerequisite, ENEE 218 or equivalent. The theory of imaging radar systems. Classifications, resolution mechanisms, and principles. System design for additive noise: Effects of ambiguity, multiplicative noise, motion errors, nonlinearities, and scattering mechanism. System design for ambiguity and multiplicative noise. Optical processing. Application to synthetic aperture, astronomical, and hologram radar. (Harger)

ENEE 236. System Theory. (3)
Prerequisite, ENEE 153 or equivalent. Modelling of Systems, abstract definition of state, linearity and its implications, linear differential systems, controllability and observability, inpulse response, transfer functons, realization theory, nonlinear differential systems, definitions of stability, Lyapunov stability theory, the Lur'e problem and Popov condition, input/output stability. (Levine)

ENEE 237. Mathematics of Optimization. (3)
Prerequisite, ENEE 153 or equivalent and a 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. (Weiss)

ENEE 238. Sampled-Data Control Systems. (3)
Prerequisite, Undergraduate or graduate preparations in linear feedback control theory. Z-transform and modified Z-transform method of analysis, root-locus and frequency-response methods of analysis, discrete and continuous compensation, analysis with finite pulse width, digital control systems. (Emad)

ENEE 239. Optimization and Control. (3)
Prerequisite, ENEE 237. Definition and condition of optimization problems, calculus of variations, dynamic programming, maximum principle, applications including recursive and algorithmic computing methods. (Levine)

ENEE 240. Advanced Topics in Control Theory. (3)
Prerequsite as announced. Topics selected, as announced, from advanced control theory and its applications. (Staff)

COMPUTERS

For Graduates and Advanced Undergraduates

ENEE 100. Introduction to Computers and Computation. (3)
Prerequisite, ENES 83 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. (Abrams)

ENEE 102. Introduction to Discrete Structures. (3)
Prerequsite, ENES 83 or equivalent. This is the same course as CMSC 102. 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. (Ramanujacharyulu)

ENEE 104. Introduction to Switching System Design. (3)
Prerequisite, ENEE 100. Symbolic logic and Boolean algebra; switching circuits; minimization algorithms; basic sequential circuits; design of digital systems. (Pugsley)

ENEE 106. Fundamentals of Computer Systems. (3)
Prerequisite, ENEE 104. Digital Computer organization; arithmetic elements; primary

and secondary storage; applications of integrated circuits; operating systems; interaction of hardware and software. (Marcovitz)

ENEE 108. Introduction to Automata Theory. (3)
Prerequisite, ENEE 102 or permission of the instructor. An introduction to finite state machines and their properties; properties of regular sets; elementary decomposition results; introduction to Turning machines and computability theory; undecidability prooositions; introduction to finite semigroups with applications to the decomposition of finite state machines. (Weiss)

ENEE 112. Introduction to Computer-Aided Analysis and Design. (3)
Prerequisites, ENES 83, ENEE 122. Application of digital computers to solutions of lumped parameter system problems; use of simulators; economic and reliability considerations; investigation and applications of problem oriented programs such as those for circuit analysis, (e.g. CORNAP, JOBSHOP, ECAP, and NASAP). The use of the computer will be an integral part of the course. (Lin)

ENEE 160. Analog and Hybrid Computers. (3)
Prerequisite, ENEE 122. Programming the analog computer; analog computing components; error analysis, repetitive operation; synthesis of systems using the computer; hybrid computer systems. (Emad)

ENEE 163. Digital Logic Laboratory. (1)
Prerequisite, ENEE 162 or equivalent. Design, breadboard construction and checkout of simple digital systems such as counters, shift registers, arithmetic and control units. (Pugsley)

ENEE 166. Digital Computer Organization. (3)
Prerequisite, ENES 83 or CMSC 100 or equivalent. Same as CMSC 160. 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.) (Pryor)

For Graduates

ENEE 260. Arithmetic and Coding Aspects of Digital Computers. (3)
Prerequisite, ENEE 166 or 106 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. (Rao)

ENEE 261. Coding Theory and Applications. (3)
Prerequisite, ENEE 102 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. (Rao)

ENEE 262. Combinatorial Switching Theory. (3)
Prerequisites, ENEE 102 and ENEE 104. 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. (Pugsley)

ENEE 263. Structure Theory of Machines. (3)
Prerequisites, ENEE 102 and ENEE 104. Machine realizations; partitions and the substitution property; pair algebras and applications; variable dependence; decomposition; loop-free structures; set system decompositions; semigroup realizations. (Marcovitz)

ENEE 265. Automata Theory. (3)
Prerequisite, ENEE 108 or CMSC 206. This is the same course as CMSC 220. 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. (Weiss)

ENEE 270. Digital Computer Design. (3)
Prerequisite, ENEE 106. 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. (Pugsley)

ENEE 272. Topics in Computer Design. (1-3 variable)
Prerequisite, permission of the instructor. Such topics as computer arithmetic, computer reliability, and threshold logic will be considered. May be taken for repeated credit. (Staff)

ENEE 274. Digital Systems Engineering. (3)
Prerequisite, 270. 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. (Marcovitz)

ENEE 276. Simulation of Dynamic Systems. (3)
Prerequisite, ENEE 100. Mechanistic methods for differential equation solution; application of analog or hybrid computers and digital differential analyzers for that purpose; design and structure of languages for digital-analog simulation on a general purpose digital computer; MIMIC Languages and examples of its use. Class will run simulation programs on a large-scale computer. (Chu)

ELECTROPHYSICS

For Graduates and Advanced Undergraduates

ENEE 130. Electromagnetic Theory. (3)
Three hours of lecture per week. Prerequisites, MATH 22, PHYS 31, ENEE 90 with an average grade of C or better in MATH 21, 22, PHYS 20, 21, and ENEE 90. Required of Juniors in Electrical Engineering. Introduction to electromagnetic fields. Electrostatics; Coulomb's law, Gauss' Law, electrical potential, capacitance, Laplace's equation and boundary value problems. Magnetostatics; Biot-Savart law, Ampere's law, Lorentz force equation, magnetic materials, inductance. Time varying fields and Maxwell's equations. (Reiser)

ENEE 132. Electromagnetics of Materials. (3)
Three hours of lecture per week. Prerequisite, ENEE 130. Required of seniors in Electrical Engineering. Review of Maxwell's equations; the wave equation; electron dynamics with applications to accelerators; dielectrics; the dielectric model for plasmas; plane waves in magnetoplasmas. Introduction to quantum mechanics and quantum statistics; theory of semi-conductors. Ferromagnetism and selected topics. (Lieberman)

ENEE 134. Electromagnetic Propagation. (3)
Three hours of lecture per week. Prerequisite, ENEE 130. Required of seniors in Elec-

trical Engineering. The wave equation and the impedance concept; plane waves; reflection and refraction; waveguides and transmission lines; Smith charts; lumped models. (Lee)

ENEE 135. Electromagnetic Measurements Laboratory. (1)
Two hours of laboratory per week. Co-requisite, ENEE 134. Laboratory to be taken in association with ENEE 134. Experiments on field mapping, transmission line matching, impedance measurement, microwave measurements of standing wave ratio, power, frequency, Q, and coupling. (Friedman)

ENEE 170. Antennas and Wave Propagation. (3)
Three hours of lecture per week. Prerequisite, ENEE 134. Review of Maxwell's equations, radiation, antenna fundamentals, antenna arrays, aperture antennas, impedance concepts and propagation. (Friedman)

ENEE 186. Particle Accelerators, Physical and Engineering Principles. (3)
Three hours of lecture per week. Prerequisites, ENEE 130 and Physics 153, 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. (Kim)

ENEE 188. Physical Electronics of Devices. (3)
Three hours of lecture per week. Prerequisite, Physics 153 and ENEE 132. Introduction to electron and ion optics. Principles of vacuum tubes, klystrons and magnetrons. Conductivity of metals and semiconductors. P-n junction and transistors. (Kim)

For Graduates

ENEE 200. Electromagnetic Theory I. (3)
Two lectures per week. Prerequisite, ENEE 134 or equivalent. Theoretical analysis and engineering applications of Maxwell's equations. First semester: Boundary value problems of electrostatics and magnetostatics. Second semester: The homogeneous wave equation. Plane wave propagation. The interaction of plane waves and material media. Retarded potentials. The Hertz potential. Simple radiating systems. (Hochuli)

ENEE 201. Electromagnetic Theory III. (3)
Two lectures per week. Prerequisite, ENEE 200. Continuation of ENEE 200. (LeVine)

ENEE 206. Microwave Engineering. (3)
Two lectures per week. Prerequisite, ENEE 201. Mathematical methods for the solution of the wave equation, transmission lines and waveguides, selected topics in the theory of waveguide structures, surface guides and artificial dielectrics. (Friedman)

ENEE 207. Optical Engineering II. (3)
Two lectures per week. Prerequisite, may be taken concurrently with ENEE 201. Fourier Analysis in two demensions, Diffraction Theory, Optical Imaging Systems, Spatial Filtering, Holography. (Taylor)

ENEE 209. Quantum Electronics. (3)
Two lectures per week. Prerequisite, a course in quantum mechanics or consent of instructor. Quantization of electromagnetic radiation, spontaneous emission, interaction of radiation and atoms, optical resonators, lasers and laser systems, semiconductor lasers, electro-optic effect and electro-optic modulation. (Hochuli)

ENEE 210. Solid State Electronics. (3)
Two lectures per week. Prerequisite, a course in quantum mechanics or consent of instructor. Properties of crystals; elementary topics from quantum mechanics; 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. (Lieberman)

ENEE 215. Radio Wave Propagation I. (3)
Two lectures per week. Prerequisite, ENEE 201. General Solutions of Maxwell's equations geometrical optics approximations, propagation above a plane earth, dipoles above earth, effects of surface irregularities and stratified atmospheres, scattering by turbulence. (Taylor)

ENEE 216. Radio Wave Propagation II. (3)
Two lectures per week. Prerequisite, ENEE 215. Continuation of ENEE 215. (LeVine)

ENEE 250. Mathematics for Electromagnetism. (3)
Prerequisite, Undergraduate preparation in Electromagnetic Theory and Advanced Calculus. Tensors and cirvilinear coordinates, partial differential equations of electrostatics and electrodynamics, functionals, integral equations, and calculus of variations as applied to electromagnetism. (Taylor)

ENEE 251. Antenna Theory. (3)
Two lectures per week. Prerequisite, ENEE 201 or equivalent. Review of Maxwell's equations; radiative networks; linear antennas; antenna arrays; aperture antennas; advanced topics. (Friedman)

ENEE 282. Integrated Electronics. (3)
Three hours per week. Prerequisite, ENEE 122. Semiconductor resistance; semiconductor capacitance; Junction diode and transistor characteristics; resistance and capacitance multiplication; temperature effects; operational amplifiers; Complementary transistors and applications; integrated logic circuits; integrated control and regulator circuits; MOS devices and arrays; Isolation; interconnections; large scale integration; frequency selectivity; thin film circuits. (Lin)

ENEE 283. Semiconductor Devices and Technology. (3)
Three hours per week. Prerequisite, consent of the instructor. Bipolar transistors; junction field effect transistors; insulated gate field effect transistors; silicon control rectifiers; tunnel diodes; unijunction transistor fabrication of semiconductor devices; crystal growth; epitaxy; diffusion; oxidation; photo-lithography; contacts; packaging. (Lin)

ENEE 290. Charged Particle Dynamics. (3)
Three hours per week. Prerequisite, consent of the 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. (Reiser)

TOPICS, SEMINARS AND RESEARCH

For Graduates and Advanced Undergraduates

ENEE 180. Topics in Electrical Engineering. (3)
Every semester two or more specialized courses are offered by visiting or regular Electrical Engineering faculty members from the following:

a. Topics in Biomedical Engineering
b. Topics in Circuit and System Theory
c. Topics in Communication and Control
d. Topics in Computers
e. Topics in Electrophysics

The student should check with the Electrical Engineering office of Graduate Studies for a list and descriptions of the exact topics offered the semester he intends to register. (Staff)

ENEE 181. Projects in Electrical Engineering. (1-3)
Hours to be arranged. Prerequisite, senior standing and permission of the instructor. Theoretical and experimental projects arranged by an individual or a small group of students with an Electrical Engineering faculty member on a mutually agreed topic in any of the topics listed under ENEE 180. (Staff)

For Graduates

ENEE 222. Graduate Seminar. (1-3)
Prerequisite, consent of instructor. Every semester regular seminars are held in Electrical Science and in the five areas of specialization offered by the Electrical Engineering Department. They maybe taken, by arrangemnt with the student's advisor, for repeated credit. (Staff)

ENEE 223. 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 ENEE 180. The student should check with the Electrical Engineering office of Graduate Studies for a list and the description of the topics offered currently. (Staff)

ENEE 399. Thesis Electrical Engineering Research. (Master's Level)
Prerequisite, consent of the thesis advisor. The thesis topic must be in one of the areas of specialization offered by the Electrical Engineering Department: a) biomedical engineering, b) circuits, c) communication and control, d) computers or e) electrophysics. A master thesis is required of all M.S. candidates in Electrical Engineering. (Staff)

ENEE 499. Thesis Electrical Engineering Research. (Doctoral Level)
Prerequisite, consent of the thesis advisor. Before registering for doctoral thesis research the student must successfully have passed the Ph.D. qualifying examination and must have been accepted for specialization by one of the areas listed under ENEE 399. (Staff)

ENGLISH LANGUAGE AND LITERATURE

Professors: Freedman, Bode, Cooley, Harman *(Emerita),* Hovey, Korg, Lutwack, McManaway, Manning, Mish, Murphy, Myers, Panichas, Russell, Whittemore, and Zeeveld.

Associate Professors: Alkon, Barnes, Barry, Birdsall, Brown, Bryer, Carey, Cooper, Fleming, Gravely, Herman, Houppert, Jellema, Kinnaird, Lawson, Pitts, Portz, D. Smith, G. Smith, Thorberg, Vitzthum, Ward, Weber *(Emeritus),* and Wilson.

Assistant Professors: Cate, Coulter, Fry, Greenwood, Hamilton, Holton, Howard, James, Kenney, Kleine, Martin, Miller, Rutherford, Saltz, Spurgeon, Steinberg, Van Egmond, Walt, and Weigant.

The Department of English offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy.

Departmental requirements for the degree of Master of Arts include: (1) ENG 201; (2) three credits from the following: ENG 102, 105, 107, 108, 161;

(3) six credits in the English 260 series. Candidates must meet a foreign language requirement by either (1) passing The Graduate School reading examination in French or German; or (2) submitting a record of 12 undergraduate credits, with an average grade of C or better, in one of the following languages: French, German, Greek, Latin, Italian, Russian, Spanish. Students who wish to continue their work in this Department towards the doctorate will be expected to elect the first alternative.

Departmental requirements for the degree of Doctor of Philosophy include: (1) a foreign language requirement, (2) six 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 18 hours beyond the Master of Arts and must be taken upon the completion of 30 hours.

For Graduates and Advanced Undergraduates

ENGL 101. History of the English Language. (3)
(Herman, Rutherford, Steinberg)

ENGL 102. Old English. (3)
(Rutherford, Steinberg)

ENGL 104. Chaucer. (3)
(Cooley, Rutherford)

ENGL 105. Introduction to Linguistics. (3)
(Same as Foreign Language 101.) (Tuniks)

ENGL 107. American English. (3)
(Miller)

ENGL 108. Advanced English Grammar. (3)
(James)

ENGL 109. English Medieval Literature in Translation. (3)
(Birdsall)

ENGL 110, 111. Elizabethan and Jacobean Drama. (3, 3)
(Houppert, D. Smith, Spurgeon, Zeeveld)

ENGL 112, 113. Literature of the Renaissance. (3, 3)
(Cooper, Spurgeon, Zeeveld)

ENGL 115, 116. Shakespeare. (3, 3)
(Cooper, Houppert, D. Smith, Spurgeon, Zeeveld)

ENGL 117. Shakespeare: The Major Works. (3)
(D. Smith)

ENGL 120. English Drama from 1660 to 1800. (3)
(D. Smith, Ward)

ENGL 121. Milton.
(Freedman, Hamilton, Mish, Murphy)

ENGL 122. Literature of the Seventeenth Century, 1600-1660. (3)
(Hamilton, Mish, Wilson)

ENGL 123. Literature of the Seventeenth Century, 1660-1700. (3)
(Hamilton, Mish, Wilson)

ENGL 125, 126. Literature of the Eighteenth Century. (3, 3)
(Alkon, Myers, Saltz)

ENGL 129, 130. Literature of the Romantic Period. (3, 3)
(Heward, Kinnaird, G. Smith)

ENGL 134, 135. Literature of the Victorian Period. (3, 3)
(Brown, Cate, Pitts)

ENGL 136. Late Victorian and Edwardian Literature (3)
(Brown, Cate, Pitts)

ENGL 139, 140. The English Novel. (3, 3)
(Kenney, Ward)

ENGL 141. Major British Writers. (3)
(Staff)

ENGL 142. Major British Writers. (3)
(Staff)

ENGL 143. Modern Poetry. (3)
(Fleming, Jellema)

ENGL 144. Modern Drama. (3)
(Barry, Bryer, Freedman, Tinsley)

ENGL 145. The Modern Novel. (3)
(Holton, Lawson, Panichas)

ENGL 146. American Drama. (3)
(Bryer)

ENGL 147. American Poetry. (3)
(Van Egmond)

ENGL 148. The Literature of American Democracy. (3)
(Barnes)

ENGL 152. The Novel in America to 1910. (3)
(Hovey, Lawson, Thorberg)

ENGL 153. The Novel in America Since 1910. (3)
(Hovey, Lawson, Thorberg)

ENGL 154. Literature of the South. (3)
(Lawson)

ENGL 155, 156. Major American Writers. (3, 3)
(Bryer, Gravely, Lawson, Lutwack, Manning)

ENGL 157. Introduction to Folklore. (3)
(Birdsall, Carey)

ENGL 158. Folk Narrative. (3)
(Birdsall, Carey)

ENGL 159. Folksong and Ballad. (3)
(Birdsall, Carey)

ENGL 160. Advanced Expository Writing. (3)
(Beauchamp, Herman, Stevenson, Townsend, Walt)

ENGL 161. Advanced English Structure. (3)
(Miller)

ENGL 165. American Folklore. (3)
(Fry)

ENGL 166. Afro-American Folklore and Culture. (3)
(Fry)

ENGL 167. Afro-American Literature. (3)
(Naughton)

ENGL 168. Urban Folklore. (3)
(Birdsall)

ENGL 170. Creative Writing. (3)
(Fleming, Jellema)

ENGL 171. Advanced Creative Writing. (3)
(Fleming, Jellema)

ENGL 172. Playwriting. (3)
(Fleming)

ENGL 175. Literary Criticism. (3)
(Lutwack)

ENGL 179. Special Studies in English and American Literature. (3)

ENGL 180. American Literature to 1810. (3)
(Barnes, Vitzthum)

ENGL 181. American Literature, 1810-1865. (3)
(Bryer, Carey, Gravely, Hovey, Lawson, Martin, Thorberg, Van Egmond, Vitzthum)

ENGL 182. American Literature, 1865-1915. (3)
(Dunn, Gravely, Hovey, Thorberg, Van Egmond)

ENGL 183. American Literature, 1915 to the Present. (3)
(Bode, Carey, Hovey, Lawson, Moore, Van Egmond)

ENGL 190, 191. Honors Conference and Reading. (1, 1)
(Saltz, Vitzthum)

ENGL 199. Senior Proseminar in Literature. (3)
(Saltz, Vitzthum)

ENGL 201. Bibliography and Methods. (3)
(Bryer, Cooper, Hovey, Mish, D. Smith)

ENGL 202. Middle English. (3)
(Steinberg)

ENGL 204. Seminar in Medieval Literature. (3)
(Cooley)

ENGL 206, 207. Seminar in Renaissance Literature. (3, 3)
(McManaway, Mish, Zeeveld)

ENGL 210, 211. Seminar in Seventeenth Century Literature. (3, 3)
(Freedman, Mish, Murphy, Wilson)

ENGL 212, 213. Seminar in Eighteenth Century Literature. (3, 3)
(Howard, Myers, Saltz)

ENGL 214, 215. Seminar in Nineteenth Century Literature. (3, 3)
(Brown, Kinnaird, Pitts, G. Smith)

ENGL 216, 217. Literary Criticism. (3, 3)
(Lutwack)

ENGL 218. Seminar in Literature and the Other Arts. (3)
(Myers)

ENGL 225, 226. Seminar in American Literature. (3, 3)
(Bode, Hovey, Lawson, Lutwack)

ENGL 227, 228. Problems in American Literature. (3, 3)
(Vitzthum)

ENGL 241, 242. Studies in Twentieth Century Literature. (3, 3)
(Bode, Hovey, Lawson, Panichas)

ENGL 244. Studies in Drama. (3)
(Barry, Bryer, Freedman)

ENGL 245. Studies in Fiction. (3)
(Mish)

ENGL 257. Seminar in Folklore. (3)
(Carey)

ENGL 260. Special Studies in Medieval English Literature. (3)
(Cooley)

ENGL 261. Special Studies in Renaissance English Literature. (3)
(Cooper)

ENGL 262. Special Studies in Seventeenth-Century English Literature. (3)
(Murphy)

ENGL 263. Special Studies in Eighteenth-Century English Literature. (3)
(Saltz)

ENGL 264. Special Studies in English Romantic Literature. (3)
(Kinnaird)

ENGL 265. Special Studies in English Victorian Literature. (3)
(Brown)

ENGL 266. Special Studies in American Literature to 1865. (3)
(Weigant)

ENGL 267. Special Studies in American Literature After 1865. (3)
(Lutwack)

ENGL 302. Studies in British Literature. (3)
(Staff)

ENGL 303. Studies in American Literature. (3)
(Staff)

ENGL 399. Thesis Research (Master's Level.) (1-6)
(Staff)

ENGL 499. Dissertation Research. (Doctoral Level.) (1-6)
(Staff)

ENTOMOLOGY

Professors: Bickley, Cory (*Emeritus*), Jones and Langford.
Associate Professors: Harrison, Menzer, Messersmith, and Steinhauer.
Assistant Professors: Davidson and Haviland (*Emeritus*).
Lecturers: Heimpel and Spangler.

The Department of Entomology offers work toward the degrees of Master of Science and Doctor of Philosophy.

For Graduates and Advanced Undergraduates

ENTM 100. Advanced Apiculture. (3)
Second semester. One lecture and two three-hour laboratory periods a week. Prerequisite, ENTM 004. Not offered 1970-71.

ENTM 105. Medical and Veterinary Entomology. (4)
(Second semester.) Three lectures and one two-hour laboratory period a week. Prerequisite, ENTM 015 or consent of 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. (Messersmith)

ENTM 107. Insecticides. (2)
Second semester. Prerequisite, consent of the Department. The development and use of contact and stomach poisons, fumigants and other important chemicals, with reference to their chemistry, toxic action, compatibility, and host injury. Recent research emphasized. (Menzer)

ENTM 120. Insect Taxonomy and Biology. (4)
First semester. Two lectures and two three-hour laboratory periods a week. Prerequisite, ENTM 015. Introduction to the principles of systematic entomology and the study of all orders and the important families of insects; immature forms considered. (Davidson)

ENTM S121. Entomology for Science Teachers. (4)
Summer session. 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. (Staff)

ENTM 122. Insect Morphology. (4)
Second semester. Two lectures and two three-hour laboratory periods a week. Prerequisite, ENTM 015. A basic study of insect form, structure and organization in relation to function. (Davidson)

ENTM 123. Insect Physiology. (4)
Second semester. Two lectures and two three-hour laboratory periods a week. Prerequisites, ENTM 015, CHEM 031 or equivalent. Lectures and laboratory exercises on the cuticle, growth, endocrines, muscles, circulation, nerves, digestion, excretion and reproduction in insects. (Jones)

ENTM 124. Economic Entomology. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, ENTM 015. The recognition, biology and control of insects injurious to fruit and vegetable crops, field crops and stored products. (Harrison)

ENTM 125. Insect Pathology. (3)
Second semester. Two lectures and one three-hour laboratory period per week. Prerequisite, MICB 001; prerequisite or concurrent ENTM 123, or consent of the instructor. An introduction to the principal insect pathogens with special reference to symptomology, epizootiology, and microbial control of insect pests. (Reichelderfer)

ENTM 198. Special Problems. (1-3)
First and second semesters. Credit and prerequisites, to be determined by the Department. Investigation of assigned entomological problems. (Staff)

ENTM 199. Seminar. (1, 1)
First and second semesters. Prerequisite, senior standing. Presentation of original work, reviews and abstracts of literature. (Bickley)

For Graduates

ENTM 205. 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. (Harrison)

ENTM 206. 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. (Offered 1970-71) (Bickley)

ENTM 208. Toxicology of Insecticides. (4)
First semester. Three lectures and one three-hour laboratory period a week. (Alternate years, not offered 1969-70.) Prerequisite, CHEM 031 or 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. (Menzer)

ENTM 209. Advances in Insect Physiology. (2)
First semester, alternate years. Two lectures a week. Prerequisites, ENTM 123 or consent of instructor. Lectures on current literature with reading assignments and discussion. (Jones)

ENTM 210. Entomological Topics. (Credit arranged)
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.
(Staff and visiting lecturers)

ENTM 211. 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, and specialized subjects of current interest such as light production, insect pigment formation, pheromones, venoms, and chemical defense mechanisms. (Menzer)

ENTM 301. 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. (Staff)

ENTM 399. Thesis Research. (Master's Level)
First and second semesters. (Staff)

ENTM 499. Dissertation Research. (Doctoral Level)
(Staff)

FOOD SCIENCE

Professors: Stark,* Kramer, Scott, Twigg and Wiley *(Horticulture)*. Davis, Arbuckle, King and Mattick *(Dairy Science)*. Shaffner *(Poultry Science)*, Young *(Animal Science)*.
Associate Professor: Buric *(Animal Science)*.
Assistant Professors: Bigbee *(Poultry Science)* and Heath *(Poultry Science)*.
Lecturer: Sulzbacker.

Graduate courses of study in food science leading to the degrees of Master of Science and Doctor of Philosophy are offered under the aegis of

*Chairman of Program.

the Departments of Dairy Science, Horticulture, Animal Science and Poultry Science. The student may pursue work in the chemical, physical, bacteriological, and nutritional aspects of food products.

Applicants for admission should contact the chairman of the program for information on specific requirements.

For Graduates and Advanced Undergraduates

FDSC 102. Principles of Food Processing—I. (3)
Second semester. Two lectures and one laboratory a week. (Wiley)

FDSC 103. Principles of Food Processing—II. (3)
First semester. Three lectures a week. (Mattick)

FDSC 111. Food Chemistry. (3)
First semester. Two lectures and one laboratory a week. Prerequisites, CHEM 010 and 012. (King)

FDSC 112. Analytical Quality Control. (3)
Second semester. Two lectures and one laboratory a week. Prerequisites, CHEM 010 and 012. Instrumental and sensory measurement of food quality attributes including appearance, rheological, flavor, and microbiological evaluations, and their integration into grades and standards of quality. (Kramer)

FDSC 113. Statistical Quality Control. (3)
First semester. Two lectures and one laboratory a week. Prerequisite, AGRI 100. Statistical methods for acceptance sampling of supplies and raw materials; in-plant and finished product inspection, water, fuel, and waste control, production transportation, inventory and budget controls. (Kramer)

FDSC 125. Meat and Meat Processing. (3)
First semester, alternate years. Two lectures and one laboratory a week. Prerequisite, CHEM 161 or permission of instructor. (Sulzbacher)

FDSC 131. Food Product Research and Development. (3)
Second semester. Two lectures, one laboratory a week. Prerequisite, FDSC 103, CHEM 161 or permission of instructor. (Mattick)

FDSC 156. Horticultural Products Processing. (3)
Second semester, alternate years. Two lectures and one laboratory a week. Laboratory fee $5.00. (Wiley)

FDSC 160. Technology of Market Eggs and Poultry. (3)
First semester, alternate years. Two lectures and one laboratory a week. (Heath)

FDSC 175. Seafood Products Processing. (3)
Second semester, alternate years. Two lectures and one laboratory a week. Prerequisite, CHEM 161 or permission of instructor.

FDSC 182. Dairy Products Processing. (3)
First semester, alternate years. Two lectures and one laboratory a week. (Mattick)

Mechanics of food processing, see Agricultural Engineering, AGEN 113.

Experimental Food Science, see Home Economics, FOOD 153.

For Graduates

FDSC 201. Advances in Food Technology. (3)
First semester, alternate years. Prerequisite, CHEM 161 or permission of instructor. (Kramer)

FDSC 301. Special Problems in Food Science. (1 to 4)
First and second semesters. Prerequisite, CHEM 161 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 302. Seminar in Food Science. (1-3)
First or second semesters. Prerequisite, CHEM 161. A study in depth of a selected phase of food science.

A) Lipids
B) Proteins
C) Carbohydrates
D) Organoleptic Properties
E) Fermentation
F) Enzymes and Microorganisms in Food Synthesis
G) Flavor Analysis
I) Assays

FDSC 310. 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. (Staff)

FDSC 399. Thesis Research. (1-12)
First and second semesters; summer session. The investigation is planned and conducted under faculty supervision. Grades are awarded on completion of the masters thesis.

FDSC 499. Dissertation Research. (Doctoral Level). (1-12).
First and second semesters; summer session.

Methods of Horticultural Research, see Horticulture, HORT 207.

Research Methods, see Dairy Science, ANSC 241.

Recent Advances in Nutrition, see Home Economics, NUTR 204.

FRENCH AND ITALIAN LANGUAGE AND LITERATURE

Professors: MacBain *(Head),* Bingham, Guyon *(Visiting Professor),* Monchoux *(Visiting Professor),* Quynn *(Emeritus),* and Rosenfield.
Associate Professors: Demaitre, Hall, and Tarica.
Assistant Professors: Fink, Gilbert, Hicks, Lebreton-Savigny, Salchenberger.
Lecturers: Lloyd-Jones and Meijer.

MASTER OF ARTS

In addition to specified course work, candidates must pass a written examination based primarily on a reading list established by the Department. The examination will test the general familiarity of the candidate with the most significant landmarks in French literature, together with his powers of analysis and criticism, and his proficiency in the French language. Both Master of Arts options (thesis and non-thesis) entail an oral examination.

DOCTOR OF PHILOSOPHY

Both major and minor work may be taken within the Department. In addition to specified course work, candidates must pass a written qualifying examination at least one year before the degree is awarded. Topics for the examination are chosen by the student subject to the approval of his advisers.

Attention is called to the courses in Comparative Literature.

For Graduates and Advanced Undergraduates

FREN 000. Intensive Elementary French. (Audit)
First and second semesters and summer session. Graduate students should register as auditors only. Intensive elementary course in the French language designed particularly for graduate students who wish to acquire a reading knowledge. (Staff)

FREN 101. Applied Linguistics. (3)
The nature of Applied Linguistics and its contributions 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. (Staff)

FREN 103. Advanced Composition. (3)
Study of word formation, specialized vocabularies, idiomatic constructions, review of certain points of grammar, translation from English to French, and free composition. (Lloyd-Jones)

FREN 104. 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 student to understand literature in depth and make mature aesthetic evaluations of it. (Fink)

FREN 107-108. Introduction to Medieval Literature (3, 3)
French literature from the ninth through the fifteenth century. First semester: la chanson épique, le roman courtois, le lai. Second semester: la littérature bourgeoise, le théâtre, la poésie lyrique. (Lloyd-Jones)

FREN 111-112. French Literature of the Sixteenth Century. (3, 3)
The Renaissance in France: humanism, Rabelais, Calvin, Montaigne, the Pléiade, baroque poetry. (Lloyd-Jones, Meijer)

FREN 115-116. French Literature of the Seventeenth Century. (3, 3)
First and second semesters. First semester: Descartes, Pascal, Corneille, Racine. Second semester: the remaining great classical writers, with special attention to Molière. (Rosenfield)

FREN 125-126. French Literature of the Eighteenth Century. (3, 3)
First and second semesters. First semester: development of the philosophical and scientific movement; Montesquieu. Second semester: Voltaire, Diderot, Rousseau. (Bingham, Fink)

FREN 131-132. French Literature of the Nineteenth Century. (3, 3)
First and second semesters. First semester: drama and poetry from Romanticism to Symbolism. Second semester: the major prose writers of the same period. (Gilbert, Lebreton-Savigny)

FREN 143, 144, 145. STUDIES IN 20th CENTURY LITERATURE. (3, 3, 3)

FREN 143. The Early Years.
French poetry, theater and the novel during the age of Proust and Gide.

FREN 144. Mid-Century Writers.
Modern French poetry, theater and the novel, with special emphasis on the literature of anxiety and Existentialism.

FREN 145. The Contemporary Scene.
French writers and literary movements since about 1950, with special emphasis on new forms of the novel and theater. (Demaitre, Tarica)

FREN 171-172. French Civilization. (3, 3)
First and second semesters. French life, customs, culture, traditions. First semester: the historical development. Second semester: present-day France. (Meijer, Lebreton-Savigny)

FREN 181-182. Pro-Seminar in Great Literary Figures. (3, 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. (Staff)

For Graduates

FREN 201. The History of the French Language. (3)
A rapid survey of the major phenomena of French linguistic history, considered from the internal and external points of view. Introduction to linguistic terminology. (MacBain)

FREN 203. Comparative Romance Linguistics. (3)
A comparative study of the principal Romance languages: phonology, morphology, syntax, lexicon. (Mendeloff)

FREN 207. Elementary Old French. (3)
An introduction to Old French accidence and vocabulary through the reading of the *Chanson de Roland*. Readings in modern French of representative works of Old French literatura. (MacBain)

FREN 208. Old French Phonology and Morphology. (3)
Phonological changes from Vulgar Latin to Old French; the resultant Old French accidence and morphological changes from Vulgar Latin to Old French. Prerequisite, some knowledge of Latin desirable. (MacBain)

FREN 209. Medieval French Culture. (3)
Extensive readings in modern French translations of the masterpieces of Old French literature: lectures and readings on the historical and social setting of these works in feudalism. (Staff)

FREN 210. Elementary Old Provençal. (3)
The essentials of Old Provençal phonology and morphology necessary to reading; readings in Old Provençal lyric poetry and other representative literary works. Prerequisite, some knowledge of Latin desirable. (Staff)

FREN 213-214. Seminar in French Renaissance. (3, 3)
(Staff)

FREN 215-216. Seminar in Molière. (3, 3)
(Rosenfield)

FREN 218-219. Seminar in French Classicism. (3, 3)
(Rosenfield)

FREN 220-221. The Age of Enlightenment. (3, 3)
The literature of ideas from Bayle to Condorcet. (Bingham)

FREN 230. Seminar in Romanticism. (3)
Sources and theories of French romanticism will be studied, along with works of major French romantic writers. Different writers or genres will be stressed from year to year. (Demaitre)

FREN 231. Seminar in Nineteenth-Century Post-Romantic Writers. (3)
(Staff)

FREN 235-236. The Realistic Novel in the Nineteenth Century. (3, 3)
The main works of Balzac, Stendhal, Flaubert, the Goncourts, Zola, Maupassant, and Daudet. (Demaitre)

FREN 243-244. The Contemporary French Theater. (3, 3)
The most important writers and trends in French drama from the end of the nineteenth century to the present. (Demaitre)

FREN 245-246. Seminar in the Contemporary Novel. (3, 3)
Critical study of the entire work of a major twentieth century novelist, such as Proust, Gide, Mauriac, Duhamel. Usually a different novelist will be treated in the second semester. (Tarica)

FREN 251-252. The History of Ideas in France. (3, 3)
Analysis of currents of ideas as reflected in different periods and authors of French literature. (Rosenfield)

FREN 253. Problems in Bibliography and Research Methods. (3)
(Bingham)

FREN 261-262. Seminar in a Great Literary Figure. (3, 3)
(Staff)

FREN 271-272. Advanced Writing and Stylistics. (3, 3)
Composition, translation, *explication de textes* of both prose and poetry. (Staff)

FREN 281-282. Reading Course. (3, 3)
Designed to give graduate students a background of a survey of French literature. Extensive outside readings, with reports and periodic conferences. (Staff)

FREN 291-292. Seminar. Topic to be determined. (3, 3)
(Staff)

FREN 399. Thesis Research. (Master's Level)
Credits determined by work accomplished. Guidance in preparation of master's theses. Conferences. (Staff)

FREN 499. Dissertation Research. (Doctoral Level)
(Staff)

ITALIAN

ITAL 008-009. Accelerated Italian. (3, 3)
Open to graduate students but not for graduate credit. An intensive beginning course in the fundamentals of Italian grammar to develop a high degree of skill in reading Italian. Must be taken in sequence. (Salchenberger)

GEOGRAPHY

Professors: Ahnert, Ben-Arieh *(Visiting, Fall 1970)*, Deshler, Fonaroff, Harper, Hu and Souchez *(Visiting, Fall 1970)*.
Associate Professors: Chaves, and Wiedel.
Assistant Professors: Brodsky, Dando, Groves, Lewis, Mitchell, and Thompson.
Lecturers: Cirrincione, Kinerney, Muller, Rosenthal, and Yoshioka.

Applicants for admission to graduate work in geography should furnish graduate record examination scores and, in the case of Doctor of Philosophy candidates and all students applying for financial aid, letters of reference from persons familiar with his previous work.

A sufficiently broad background in geography at the undergraduate level is a normal prerequisite for admission to graduate study. Where such background is lacking, a student will be assigned additional work to make up for this deficiency.

A comprehensive examination, taken after completion of all course work but before the final oral examination, is required of all master's candidates.

Doctoral candidates have the option of either showing competency in two languages or one language and quantitative techniques. For the two-language option, one language must be either French, German or Russian; the other may also be selected from the preceding list or may be a language identified with the world area of the student's research interest. The quantitative techniques requirement may be met by completing prescribed courses in statistical methods.

The preliminary examination for the Doctor of Philosophy degree is given as a comprehensive written and oral examination to test the student's background knowledge and his ability to apply this knowledge independently.

Normally, acquisition of a master's degree in geography is required before a student is admitted for a course of study leading to the doctorate. Exceptions to this rule may be granted by the Department depending upon the merits of the applicant's case.

For Graduates and Advanced Undergraduates

GEOG 100. Regional Geography of Eastern Anglo-America. (3)
Prerequisite, GEOG 010, or GEOG 015, or permission of instructor. A study of the cultural and economic geography, and the geographic regions of eastern United States and Canada, including an analysis of the significance of the physical basis for present-day diversification of development, and the historical geographic background. (Staff)

GEOG 101. Regional Geography of Western Anglo-America. (3)
Prerequisite, GEOG 010, or GEOG 015, or permission of instructor. A study of western United States, western Canada, and Alaska along the lines mentioned under GEOG 100. (Staff)

GEOG 103. 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. (Cirrinciane)

GEOG 104. Geography of Major World Regions. (3)
A geographic analysis of the patterns, problems, and prospects of the world's principal human-geographic regions, including Europe, Anglo-America, the Soviet Union, the Far

East, and Latin America. Emphasis upon the causal factors of differentiation and the role geographic differences play in the interpretation of the current world scene. This course is designed especially for teachers. (Staff)

GEOG 105. Geography of Maryland and Adjacent Areas. (3)
(Dando)

GEOG 109. Introduction to Geographic Research. (3)
Development of research methods in geography including the formulation of problems, the establishment of hypotheses, development of structures for testing hypotheses, and practice with forms of geographic presentation. Maps, quantitative, and field methods will be used as appropriate. (Fonaroff, Mitchell)

GEOG 110. Economic and Cultural Geography of Caribbean America. (3)
(Chaves)

GEOG. 111. Economic and Cultural Geography of South America. (3)
(Chaves)

GEOG 118. 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. (Ahnert)

GEOG 119. 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. (Dando, Lewis)

GEOG 120. Geography of Europe. (3)
Second semester. (Staff)

GEOG 122. Economic Resources and Development of Africa. (3)
(Deshler)

GEOG 125. Geography of Asia. (3)
(Hu)

GEOG 126. Cultural Geography. (3)
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. (Fonaroff, Deshler)

GEOG 127. 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, compusition and interior expansion. Regionalization. (Mitchell)

GEOG 128. 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 the Canadian experience. Immigration, population changes and westward expansion. Changing role of primary economic activities. Industrialization, transportation and urbanization. (Mitchell, Muller)

GEOG 130. 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. (Hu)

GEOG 131. 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. (Hu)

GEOG 134. Cultural Geography of China and Japan. (3)
(Hu)

GEOG 140. Geography of the Soviet Union. (3)
(Dando)

GEOG 145. Systematic and Regional Climatology. (3)
Methodology and techniques of collecting and evaluating climatological information. A critical examination of climatic classifications. Distribution of world climates and their geographical implications. (Lewis)

GEOG 146. Regional Geomorphology. (3)
Regional and comparative morphology, with special emphasis upon Anglo-America. (Ahnert)

GEOG 150. History and Theory of Cartography. (3)
(Staff)

GEOG 151-152. Cartography and Graphics Practicum. (3, 3)
First and second semesters. One hour lecture and two two-hour laboratory periods a week. Techniques and problems of compilation, design and construction of various types of maps and graphs. Relationships between map making and modern methods of production and reproduction. Trips to representative plants. Laboratory work directed toward cartographic problems encountered in the making of non-topographic maps. (Wiedel)

GEOG 153. Problems of Cartography 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 at different scales and for different purposes. Place-name selection and lettering stickup and map composition. (Wiedel)

GEOG 154. 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. (Wiedel)

GEOG 155. Interpretation of Topographic Maps and Aerial Photographs. (3)
Two hours of lecture and two hours of laboratory per week. Interpretation of aerial photographs with emphasis on the recognition of landforms of different types and man-made features. Study of vegetation, soil, and other data that may be derived from aerial photographs. Types of aerial photographs and limitations of photo interpretation. (Staff)

GEOG 156. Quantitative Methods in Geography. (3)
The geographic applications of statistical methods. Emphasis will be placed on sources of quantitative data useful to geographers, measurements of location and association, and graphic analysis and representation of quantitative data. (Brodsky, Thompson)

GEOG 160. Advanced Economic Geography I. Agricultural Resources. (3)
First semester, alternate years. Prerequisite, GEOG 010, or GEOG 015. The nature of agricultural resources, the major types of agricultural exploitation in the world, and

the geogaphic distribution of certain major crops and animals in relation to the physical environment and economic geographic conditions. Main problems of conservation. (Deshler)

GEOG 161. Advanced Economic Geography II. Mineral Resources. (3)
First semester, alternate years. Prerequisite, GEOG 010, or GEOG 015. 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. (Staff)

GEOG 163. Water Resources and Water Resource Planning. (3)
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. (Lewis, Yoshioka)

GEOG 171. Field Course. (1, 1, 1, 1)
a—Field Study: Physical Geography
b—Field Study: Rural Areas
c—Field Study: Urban Areas
d—Field Study: Field Techniques
First semester. Training in geographic field methods and techniques. Field observation of land use in selected rural and urban area to eastern Maryland. Two lectures per week with Saturday and occasional weekend field trips. Primarily for undergraduates. (Staff)

GEOG 180. Scientific Methodology and History of Geography. (3)
First semester. For undergraduate and graduate majors in Geography. May be taken also by students with a minimum of 9 hours in systematic and 6 hours in regional geography. A comprehensive and systematic study of the history, nature, and basic principles of geography, with special reference to the major schools of geographic thought; a critical evaluation of some of the important geographical works and methods of geographic research. (Staff)

GEOG 190. Political Geography. (3)
(Chaves, Rosenthal)

GEOG 191. Population Geography. (3)
An analysis of world population distribution patterns as revealed by demographic data. Emphasis is placed upon a comparison of population density, growth, composition and migration with natural resources and state of technological advancement. Case studies from the Geographical literature will be used. (Fonaroff)

GEOG 195. 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; transportation centers and their distribution. (Thompson)

GEOG 196. 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. (Groves, Thompson)

GEOG 197. Urban Geography. (3)
Origins of cities, followed by a study of the 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. (Brodsky, Groves)

GEOG 198. Topical Investigations. (1-3)
First and second semester. 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. (Staff)

GEOG 198A. Historical Geography of Cities. (3)
(Muller)

GEOG 198B. Proseminar in Urban Geography. (3)
(Groves)

GEOG 198C. The Geography of Israel in the Middle East. (3)
This course is offered only in Fall 1970 by Dr. Ben-Arieh, a visiting professor from Hebrew University, Jerusalem.

For Graduates

GEOG 200. Field Course. (3)
Field work in September, conferences and reports during first semester. For graduate students in geography. Open to other students by special permission of the Head of the Department of Geography. Practical experience in conducting geographic field studies. Intensive training in field methods and techniques and in the preparation of reports. (Staff)

GEOG 201. Introduction to Graduate Study in Geography (3)
(Ahnert, Harper)

GEOG 202, 203. Seminar in Economic Geography. (3, 3)
Prerequisite, consent of instructor. An examination of themes and problems in the field of economic geography. (Staff)

GEOG 204, 205. Seminar in Cultural Geography. (3, 3)
Prerequisite, GEOG 126 or consent of instructor. An examination of themes and problems in the field of economic geography. (Staff)

GEOG 206, 207. Seminar in Physical Geography.
Prerequisite, consent of instructor. An examination of themes and problems in the field of physical geography. (Souchez, Ahnert)

GEOG 208. Seminar in Historical Geography (3)
(Mitchell)

GEOG 210, 211. Seminar in the Geography of Latin America. (3, 3)
First and second semesters. Prerequisite, GEOG 110, 111 or consent of instructor. An analysis of recent changes and trends in industrial development, exploitation of mineral resources and land utilization. (Chaves)

GEOG 220, 221. Seminar in the Geography of Europe and Africa. (3, 3)
First and second semesters. Prerequisite, GEOG 120, 122 or consent of instructor. Analysis of special problems concerning the resources and development of Europe and Africa. (Staff)

GEOG 230, 231. Seminar in the Geography of East Asia. (3, 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. (Hu)

GEOG 240, 241. Seminar in the Geography of the U.S.S.R. (3, 3)
First and second semesters. Prerequisite, reading knowledge of Russian and GEOG 140 or consent of instructor. Investigation of special aspects of Soviet geography. Emphasis on the use of Soviet materials. (Dando)

GEOG 246. Seminar in the Geography of the Near East. (3)
(Ben-Arieh)

GEOG 250. Seminar in Cartography. (Credit arranged.)
First or second semester. The historical and mathematical background of cartographic concepts, practices and problems, and the various philosophical and practical approaches to cartography. Discussions will be supplemented by the presentation of specific cartographic problems investigated by the students. (Wiedel)

GEOG 260. Advanced General Climatology. (3)
First semester. Prerequisite, GEOG 041, 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. (Lewis)

GEOG 261. Applied Climatology. (3)
Second semester. Prerequisite, GEOG 041, or 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. (Lewis)

GEOG 262, 263. Seminar in Meteorology and Climatology. (3, 3)
First and second semesters. Prerequisite, consent of instructor. Selected topics in meterology and climatology chosen to fit the individual needs of advanced students. (Lewis)

GEOG 280. Geomorphology. (3)
Second semester. An advanced comparative study of selected geomorphic processes and land forms; theories of land forms evolution and geomorphological problems. (Ahnert)

GEOG 290, 291. 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. (Staff)

GEOG 290A. Geographic Thought. (3)
(Hu)

GEOG 399. Thesis Research. (Master's Level)
First and second semesters and summer. (Staff)

GEOG 499. Dissertation Research. (Doctoral Level.)
(Staff)

GERMANIC AND SLAVIC LANGUAGES AND LITERATURE

Professors: Dobert, Hering *(Head)*, Kramer *(Emeritus)*, Jones, Prahl *(Emeritus)*, and Zucker *(Emeritus)*.
Visiting Professors: Klotz, Weydt.
Associate Professor: Best
Assistant Professors: Berry, Dulbey, Elder, Fleck, Hitchcock, Irwin, Knoche.

MASTER OF ARTS

Candidates must pass, in addition to written examinations in the courses pursued, a written examination based on the reading list established by the Department in their respective field of German. The examination will test the general familiarity of the candidate with his respective fields and his powers

of analysis and criticism. The oral examination will deal chiefly with the field of his thesis.

DOCTOR OF PHILOSOPHY

Candidates must pass a comprehensive written examination at least one year before the degree is awarded. This examination will include applied linguistics and each of the major literary fields.

Attention is called to the courses in Comparative Literature.

For Graduates and Advanced Undergraduates

GERM 000. Elementary German for Graduate Students. (Audit)
First and second semesters and summer session. Graduate students should register as auditors only. Intensive elementary course in the German language designed particularly for graduate students who wish to acquire a reading knowledge. (Schmeissner)

GERM 103-104. Advanced Composition. (3, 3)
First and second semesters. Translation from English into German, free composition, letter writing. (Staff)

GERM 125-126. German Literature of the 18th Century. (3, 3)
First and second semesters. The main works of Klopstock, Wieland, Lessing, Herder, Goethe, Schiller. (Knoche)

GERM 131-132. German Literature of the 19th Century. (3, 3)
First and second semesters. Study of the literary movements from romanticism to naturalism. (Irwin)

GERM 141-142. German Literature of the 20th Century. (3, 3)
First and second semesters. Prose and dramatic writings from Gerhart Hauptmann to the present. Modern literary and philosophical movements will be discussed. (Best)

GERM 171-172. German Civilization. (3, 3)
First and second semesters. Study of the literary, educational, artistic traditions: great men, customs, and general culture. (Elder)

GERM 191. Bibliography and Methods. (3)
Second semester. Especially designed for German majors. (Janes)

Attention is called to CMLT 106, *Romanticism: Flowering and Influence*, and CMLT 107, *The Faust Legend in English and German Literature.*

For Graduates

The requirements of students will determine which courses will be offered.

GERM 200. Introduction to German Studies.
(Hering)

GERM 201. History of the German Language. (3)
Lectures on the evolution of modern German. Reading and analysis of selected illustrative texts. (Fleck)

GERM 203. Gothic. (3)
An introduction to historical Germanic linguistics. A grammatical analysis and reading of selections from the Gothic Bible. (Fleck)

GERM 204. Old High German. (3)
A study of Old High German grammar, and readings from the literature of the period. (Jones)

GERM 205-206. Middle High German I, II (3, 3)
Grammar and readings in Middle High German literature. (Jones)

GERM 211-212. Literature of the 16th and 17th Centuries. (3, 3)
Study of the Reformation, Humanism and the Baroque. The main works of Luther, Sachs, Wickram, Fischart, Opitz, Gryphius, Grimmelshausen. (Hering)

GERM 224-225. Goethe and His Time. (3, 3)
The main works of Goethe and his contemporaries as reflecting the literary development from Rococo to Biedermeier. (Hering)

GERM 226. Schiller. (3)
Study of Sciller's works with emphasis on his dramas. (Dobert)

GERM 230. German Romanticism. (3)
Special consideration given to the ideas and the style of romantic writers. (Hering)

GERM 234. The German Drama of the 19th Century. (3)
Kleist, Grabbe, Büchner, Grillparzer, Hebbel, Hauptmann. (Dobert)

GERM 250. The German Lyric. (3)
Types of Lyrical poetry from "Minnesang" to Symbolism with emphasis on post-Goethean lyricists. (Dobert)

GERM 255-256. The German Novel. (3, 3)
(Hering)

GERM 258. Seminar in the German Novella. (3)
(Dobert)

GERM 281-282. Reading Course. (3, 3)
Designed to give the graduate student a background of a survey of German literature. Extensive outside readings, with reports and periodic conferences. (Best)

GERM 291-292. Seminar. (3, 3)
Topic to be determined. (Staff)

GERM 295-296. Special Topics in German Literature (3, 3)
(Staff)

GERM 399. Thesis Research. (Master's Level)
Credits determined by work accomplished. Guidance in preparation of master's theses. Conferences. (Staff)

GERM 499. Dissertation Research. (Doctoral Level)
(Staff)

RUSSIAN

RUSSIAN 103, 104. Advanced Composition. (3, 3)
(Hitchcock)

RUSSIAN 125. Russian Literature of the 18th Century. (3, 3)
(Hitchcock)

RUSSIAN 131, 132. Russian Literature of the 19th Century. (3, 3)
(Berry)

RUSSIAN 137. Modern Russian Fiction. (3)
(Dulby)

RUSSIAN 135. Modern Russian Poetry. (3)
(Hitchcock)

RUSSIAN 136. Modern Russian Drama. (3)
(Berry)

RUSSIAN 141-142. Soviet Russian Literature. (3, 3)
(Berry)

GOVERNMENT AND POLITICS

Professor and Department Head: Don C. Piper
Professors: Anderson, Burdette, Dillon, Harrison, Hathorn, Hsueh, Jacobs, McNelly and Plischke
Associate Professors: Byrd, Claude, Conway, Devine, Koury, Ranald, Reeves, Stone, Terchek, and Wolfe.
Assistant Professors: Bechtold, Butterworth, Chaples *(on leave 1970-71)*, Glass, Glendening, Heisler, Ingles *(on leave 1970-71)*, Lanning, McGregor, McCarrick, Melnick, Oliver, Spencer *(on leave 1970-71)*, Werlin, Wilkenfeld, Strouse *(Visiting 1970-71)*, and Thigpen *(Visiting 1970-71)*.
Lecturers: Barber, Flyer, King, Larson,and Levine *(Visiting 1970-71)*.

The Department of Government and Politics offers programs leading to the degrees of Master of Arts and Doctor of Philosophy. Applicants whose goal is the doctorate will receive preference. Master's degree candidates may select a thesis (30 semester credit hours) or a nonthesis 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 60 hours of course work and may take a concentration in one of the following: American politics, international relations and comparative politics, historical and empirical political theory, or public administration and urban affairs. The comprehensive examination encompasses three fields and two sub-fields, one of which may be waived on the basis of course work. An interdisciplinary area of study may be presented as one of the subfields. The examination is normally taken after completing 15 seminars, thereby permitting the student to specialize in terms of a dissertation topic during his final semester. The dissertation is defended before a faculty committee appointed by The Graduate School. In consultation with an adviser each student will prepare, during his first semester, a plan of study to include nine hours of political theory and examinations in two foreign languages or, alternatively, one language and course work in the use of quantitative research techniques.

For Graduates and Advanced Undergraduates

GVPT 101. International Political Relations. (3)
(Staff)

GVPT 102. International Law. (3)
(Harrison, Piper)

GVPT 103. Contemporary African Politics. (3)
(Werlin)

GVPT 104. Inter-American Relations. (3)
(Harrison, Barber)

GVPT 105. Recent Far Eastern Politics. (3)
(McNelly, Hsueh)

GVPT 106. American Foreign Relations. (3)
(Plischke, Barber, H. Larson)

GVPT 107. Contemporary Middle Eastern Politics. (3)
(Koury, Bechtold)

GVPT 108. International Organization. (3)
(Plischke, Wolfe)

GVPT 109. Foreign Policy of the USSR. (3)
(Jacobs, Oliver)

GVPT 110. Principles of Public Administration. (3)
(Dillon, Ingles, King, McGregor, Ranald)

GVPT 111. Public Personnel Administration. (3)
(Ingles)

GVPT 112. Public Financial Administration. (3)
(Ingles)

GVPT 113. Governmental Organization and Management. (3)
(Dillon, McGregor, Ranald)

GVPT 120. Problems in Political Behavior. (3)
(Chaples, Conway, Devine, Stone)

GVPT 122. Quantitative Political Analysis. (3)
(Devine)

GVPT 124. Legislatures and Legislation. (3)
(Chaples, Conway)

GVPT 127. Political Sociology. (3)
(Conway, Heisler)

GVPT 131. Introduction to Constitutional Law. (3)
(Hathorn, McCarrick)

GVPT 132. Civil Rights and the Constitution. (3)
(Hathorn, Claude, McCarrick)

GVPT 133. The Judicial Process. (3)
(Byrd, Flyer)

GVPT 134. Race Relations and Public Law. (3)
(McCarrick)

GVPT 141. History of Political Theory. (3)
(Anderson, Byrd, Butterworth, Claude, Glass, Terchek)

GVPT 142. Recent Political Theory: Modern and Recent. (3)
(Butterworth, Glass, Terchek)

GVPT 143. Contemporary Political Theory. (3)
(Claude, Terchek)

GVPT 144. American Political Theory. (3)
(Anderson)

GVPT 145. Russian Political Thought. (3)
(Anderson)

GVPT 154. Problems of World Politics. (3)
(Jacobs, Koury)

GVPT 160. State and Local Administration. (3)
(Dillon, Glendening)

GVPT 161. Metropolitan Administration. (3)
(Glendening, Stone)

GVPT 162. Urban Politics. (3)
(Glendening, Reeves, Stone)

GVPT 171. Problems of American Public Policy. (3)
(Hathorn)

GVPT 174. Political Parties. (3)
(Conway, Devine, Reeves)

GVPT 175. The Presidency and the Executive Branch. (3)
(Hathorn)

GVPT 178. Public Opinion. (3)
(Devine)

GVPT 181. Administrative Law. (3)
(Ingles)

GVPT 185. Comparative Study of Public Administration. (3)
(McGregor)

GVPT 189. Comparative Study of Foreign Policy Formation. (3)
(Heisler)

GVPT 190. Comparative Studies in European Politics. (3)
(Wolfe)

GVPT 191. Government and Administration of the Soviet Union. (3)
(Jacobs, Oliver)

GVPT 192. Government and Politics of Latin America. (3)
(Barber, Lanning)

GVPT 193. Government and Politics of Asia. (3)
(McNelly, Hsueh)

GVPT 194. Government and Politics of Africa. (3)
(Werlin)

GVPT 195. Government and Politics of the Middle East. (3)
(Koury, Bechtold)

GVPT 197. Comparative Political Systems. (3)
(Heisler, Lanning, Wolfe)

GVPT 199. Seminar in Government and Politics. (3)
(Staff)

For Graduates

GVPT. 200. 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. (Jacobs)

GVPT 201. Seminar in International Political Organization. (3)
A study of the forms and functions of various international organizations.
(Plischke, Piper)

GVPT 202. Seminar in International Law. (3)
Reports on selected topics assigned for individual study and reading in substantive and procedural international law. (Harrison, Piper)

GVPT 203. Functional Problems in International Relations. (3)
An examination of the major substantive issues in contemporary international relations, involving reports on selected topics based on individual research. (Staff)

GVPT 204. Area Problems in International Relations. (3)
An examination of problems in the relations of states within a particular geographic area, such as Europe, Asia and the Far East, Africa and the Middle East, and the Western Hemisphere. Individual reporting as assigned. (Staff)

GVPT 205. Seminar in American Political Institutions. (3)
Reports on topics assigned for individual study and reading in the background and development of American government. (Burdette, Hathorn, Byrd)

GVPT 206. 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. (Plischke, Barber)

GVPT 207. Seminar in Comparative Governmental Institutions. (3)
Reports on selected topics assigned for individual study and reading in governmental and political institutions in governments throughout the world. (Staff)

GVPT 208. 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.
(Harrison, Hsüeh, Koury, Melnick, Werlin)

GVPT 209. Seminar in International Administration. (3)
An analysis of the administrative aspects of international organizations with some attention given to program administration. (Plischke)

GVPT 210. Governmental Organization Theory. (3)
A study of recent developments in the area of organizational theory with an emphasis on empirical studies of organizational behavior. (Ingles, McGregor, Ranald)

GVPT 212. Seminar in Public Financial Administration. (3)
Readings and reports on topics assigned for individual or group study in the field of public financial administration. (Ingles)

GVPT 213. Problems of Public Administration. (3)
Reports on topics assigned for individual study and reading in the field of public administration. (Dillon, McGregor)

GVPT 214. Problems of Public Personnel Administration. (3)
Reports on topics assigned for individual study and reading in the field of public personnel administration. (Ingles, McGregor)

GVT 215. Problems of State and Local Government. (3)
Report of topics assigned for individual study in the field of state and local government throughout the United States. (Reeves, Glendening)

GVPT 216. Government Administrative Planning and Management. (3)
Reports on topics assigned for individual study and reading in administrative planning and management in government. (Dillon)

GVPT 217. 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. (Dillon, Stone)

GVPT 218. Seminar in Urban Administration. (3)
Selected topics are examined by the team research method with students responsible for planning, field investigation, and report writing. (Glendening, Stone)

GVPT 219. 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. (McGregor)

GVPT 221. Seminar in Public Opinion. (3)
Reports on topics assigned for individual study and reading in the field of public opinion. (Burdette, Chaples, Devine)

GVPT 222. Selected Problems in Political Behavior. (3)
Individual reading and research reports on selected problems in the study of political behavior. (Chaples, Conway, Devine)

GVPT 223. 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.
(Burdette, Chaples, Conway)

GVPT 224. Seminar in Political Parties and Politics. (3)
Reports on topics assigned for individual study and reading in the fields of political organization and action. (Burdette, Reeves, Conway)

GVPT 226. 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.
(Conway, Devine, Terchek)

GVPT 228. Problems in Quantitative Political Analysis. (3)
Prerequisite, three hours of statistics or consent of the instructor. Study of selected problems in quantitative political analysis. (Chaples, Conway, Devine)

GVPT 231. Seminar in Public Law. (3)
Reports on topics assigned for individual study and reading in the fields of constitutional and administrative law. (Claude, Hathorn, McCarrick)

GVPT 241. Great Political Thinkers. (3)
Prerequisite, GVPT 141. Intensive study of one or more men each semester.
(Anderson, Butterworth, Claude)

GVPT 242. Man and the State. (3)
Prerequisite, GVPT 142. 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.
(Anderson, Byrd, Claude, Terchek)

GVPT 243. Current Problems in Political Theory. (3)
Prerequisite, GVPT 143. Intensive examination of the development of political theory since the Second World War. (Anderson, Byrd, Claude)

GVPT 244. American Political Theory. (3)
Prerequisite, GVPT 144. Analytical and historical examination of selected topics in American political thought. (Anderson, Byrd)

GVPT 245. Seminar in Non-Western Political Theory. (3)
Intensive study of selected segments of political theory outside of the Western European tradition. (Butterworth)

GVPT 246. Theories of Democracy. (3)
Prerequisite, GVPT 142. 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. (Anderson, Byrd, Claude)

GVPT 247. Analytical Systems and Theory Construction. (3)
Prerequisite, GVPT 226. Examination of the general theoretical tools available to political scientists and of the problems of theory building. Attention is given to communi-

cations theory, decision-making, game theory and other mathematical concepts, personality theory, role theory, structural-functional analysis, and current behavioral approaches. (Tercheck)

GVPT 248. Marxist Political Theory. (3)
Prerequisite, GVPT 143 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. (Anderson)

GVPT 259. Responsibility in Public Administration. (3)
Reports and readings relating to the study of efficiency and responsiveness in public administration including the ways of achieving moral, legal, political and functional responsibility. (Ingles, McGregor)

GVPT 261. 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. (Staff)

GVPT 262. Seminar on Intergovernmental Relations. (3)
Reports on topics assigned for individual study and reading in the field of recent intergovernmental relations. (Dillon, Glendening, Reeves, Stone)

GVPT 280. 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. (McNelly, Piper, Wilkenfeld)

GVPT 290. 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. (Bechtold, Heisler, Lanning, Werlin)

GVPT 398. Readings In Government and Politics. (3)
Guided readings and discussions on selected topics in political science. (Staff)

GVPT 399. Thesis Research. (Master's Level.)
(Staff)

GVPT 499. Dissertation Research. (Doctoral Level.)
(Staff)

HISTORY

Professors: Cole, Gordon, Haber (*Chairman*), Harlan, Jashemski, Kent, Koch, Merrill, Prange, Smith, Sparks.
Associate Professors: Belz, Berry, Breslow, Brush, Callcott, Carter, Folsom, Giffin, Gilbert, Grimsted, Mayo, Schuessler, Yaney.
Assistant Professors: Beveridge, Bradbury, Brann, Cockburn, Farrell, Flack, Greenberg, Harris, Hoffman, Holum, Matossian, McCusker, Nicklason, Olson, Perinbam, Robertson, Shoufani, Stowasser, VanNess, Warren, Williams, Wright.
Lecturers: Barillari, Dunbar, Herbert, Knachel, Perry, Ridgway, Vasquez.

MASTER OF ARTS

Requirements for the Master of Arts include: (1) writing an acceptable thesis; (2) successful completion of HIST 200; (3) passing a four-hour witten examination over the major field; and (4) passing an oral examination over the thesis and the field in which it lies. At least fifteen hours of the total re-

quired for a Master of Arts must be in history, and at least nine of these shall be in the field of concentration.

DOCTOR OF PHILOSOPHY

Candidates for the Doctor of Philosophy degree in history must pass written examinations in two general fields as well as a special field within one of these general fields. The general fields are: United States history; ancient history; history of medieval and early modern Europe (6th to mid-17th centuries); modern European history; British history; Russian history; Latin American history; East Asian history; history of the Middle East and Islamic civilization; and history of Science. An examination in a special field follows successful completion of the general field examinations. A special field examination tests the kind of knowledge and depth needed to teach upper-division or advanced courses in colleges and universities. Examples of the special fields currently offered are: American diplomatic history (within the United States general field); Victorian England (within the British general field); and Russia to 1917 (within the modern Europe general field).

HIST 200 is required.

The dissertation, a prospectus of which must be approved by the student's dissertation committee before the student can be recommended formally for admission to candidacy, must constitute a contribution to historical knowledge.

The following languages are approved for the doctoral language requirements of students in history: French, German, Russian, Spanish, Italian, Portuguese, Greek, Latin, Chinese, Japanese, Arabic, Turkish Persian, and Hebrew.

Further information about requirements and procedures is available in the office of the Department.

Note: Applicants for admission to graduate work in history should take the Graduate Record Examination.

For Graduates and Advanced Undergraduates

AMERICAN HISTORY

HIST 101. American Colonial History. (3) **(McCusker)**

HIST 102. The American Revolution. (3) **(Bradbury)**

HIST 103. The Formative Period in America, 1789-1824. (3) **(Bradbury)**

HIST 107, 108. Economic History of the United States. (3, 3) **(Staff)**

HIST 109, 110. Social History of the United States. (3, 3) **(Beveridge)**

HIST 114. The Middle Period of American History, 1824-1860. (3) **(Grimsted)**

HIST 116. The Civil War. (3) **(Smith, Sparks)**

HIST 117. The Negro in American Life. (3) **(Berry, Carter)**

HIST 118. The Progressive Period: The United States, 1896-1919. (3) **(Merrill)**

HIST 119. Between the Wars: The United States, 1919-1945. (3)
(Harlan)

HIST 120. The United States Since World War II. (3)
(Olson)

HIST 121. History of the American Frontier. (3)
(Farrell)

HIST 122, 123. History of the South. (3)
(Callcott)

HIST 124. Reconstruction and the New Nation, 1865-1896. (3)
Prerequisite, HIST 021, 022, or the equivalent. (Nicklason, Smith)

HIST 127, 128. Diplomatic History of the United States. (3, 3)
(Cole)

HIST 133, 134. The History of Ideas in America. (3, 3)
Consent of the instructor is required for HIST 134. (Flack, Gilbert, Grimsted, Koch)

HIST 135, 136. Constitutional History of the United States. (3, 3)
(Belz, Berry)

HIST 137. The Scientific Revolution: From Copernicus to Newton. (3)
(Brush)

HIST 138. The Development of Modern Physical Science: From Lavoiser to Einstein. (3)
Prerequisites, MATH 010 and PHYS 002 or 003. (Brush)

HIST 141. History of Maryland. (3)
(Van Ness)

HIST 142, 143. History of Spain. (3, 3)
(Vasquez)

HIST 146. Diplomatic History of Latin America. (3)
(Warren)

HIST 147. History of Mexico and the Caribbean. (3)
(Warren)

HIST 148. History of Canada. (3)
Prerequisites, HIST 021, 042, or HIST 053, 054. (Gordon)

HIST 149. History of Brazil. (3)
(Griffin)

HIST 150. History of Argentina and the Andean Republics. (3)
(Wright)

EUROPEAN HISTORY

HIST 151. History of the Ancient Orient and Greece. (3)
(Jashemski)

HIST 153. History of Rome. (3)
(Jashemski)

HIST 155, 156. History of Medieval Europe. (3, 3)
(Robertson)

HIST 157. The Age of Absolutism, 1648-1748. (3)
(Williams)

HIST 158. The Old Regime and the French Revolution, 1748-1815. (3)
(Williams)

HIST 159, 160. History of European Ideas. (3, 3)
Prerequisites, HIST 041, 042 or HIST 053, 054, or the equivalent. (Brann, Haber)

HIST 161, 162. The Renaissance and Reformation. (3, 3)
Prerequisites, HIST 041, 042, 053, or consent of instructor. (Brann, Schuessler)

HIST 163, 164. History of the British Empire. (3, 3)
Prerequisites, HIST 041, 042, or HIST 053, 054. (Gordon)

HIST 165, 166. Constitutional History of Great Britain. (3, 3)
(Cockburn)

HIST 167, 168. History of Russia. (3, 3)
(Yaney)

HIST 169, 170. Europe in the Nineteenth Century, 1815-1919. (3, 3)
Prerequisites, HIST 041, 042, or HIST 053, 054. (Kent)

HIST 171, 172. Europe in the World Setting of the Twentieth Century. (3, 3)
Prerequisites, HIST 041, 042, or HIST 053, 054. (Harris, Prange)

HIST 173. The Soviet Union. (3)
(Staff)

HIST 175. Modern France. (3)
(Greenberg)

HIST 176. Tudor England. (3)
(Breslow)

HIST 177. Stuart England. (3)
(Breslow)

HIST 178. Britain in the Eighteenth Century. (3)
(Cockburn)

HIST 179. Modern Britain. (3)
(Gordon)

HIST 181, 182. The Middle East. (3, 3)
Prerequisites, six hours from the following groups of courses: HIST 041, 042; HIST 051, 052; or HIST 053, 054. (Shoufani)

HIST 183. A Survey of African History. (3)
(Perinbam)

HIST 184. A History of West Africa. (3)
HIST 183 recommended though not required. (Perinbam)

ASIAN HISTORY

HIST 187, 188. History of China. (3, 3)
Folsom)

HIST 189, 190. History of Japan. (3, 3)
(Mayo)

HIST 192. History of the Turks. (3)
HIST 071 and 072 recommended but not required. (Staff)

HIST 194. History of the Jews and the State of Israel. (3)
(Staff)

For Graduates

HIST 200. Historiography: Techniques of Historical Research and Writing. (3)
(Staff)

HIST 201. Readings in Colonial American History. (3)
(McCusker)

HIST 202. Seminar in Colonial American History. (3)
(McCusker)

HIST 203. Readings in the American Revolution and the Formative Period. (3)
(Bradbury)

HIST 204. Seminar in the American Revolution and the Formative Period. (3)
(Bradbury)

HIST 205. Readings in American Social and Economic History. (3)
(Beveridge)

HIST 206. Seminar in American Social and Economic History. (3)
(Beveridge)

HIST 213. Readings in Southern History. (3)
(Callcott)

HIST 214. Seminar in Southern History. (3)
(Callcott)

HIST 215. Readings in the Middle Period and Civil War. (3)
(Grimsted, Smith, Sparks)

HIST 216. Seminar in the Middle Period and Civil War. (3)
(Grimsted, Smith, Sparks)

HIST 217. Readings in Reconstruction and the New Nation. (3)
(Farrell)

HIST 218. Seminar in Reconstruction and the New Nation. (3)
(Nicklason)

HIST 223. Readings in Recent American History. (3)
(Carter, Merrill, Harlan, Olson)

HIST 224. Seminar in Recent American History. (3)
(Carter, Merrill, Harlan, Olson)

HIST 227. Readings in the History of American Foreign Policy. (3)
(Cole)

HIST 228. Seminar in the History of American Foreign Policy. (3)
(Cole)

HIST 233. Readings in American Intellectual History. (3)
(Gilbert, Grimsted, Koch)

HIST 234. Seminar in American Intellectual History. (3)
(Gilbert, Grimsted, Koch)

HIST 236. Seminar in American Constitutional and Political History. (3)
(Belz, Berry)

HIST 237. Seminar in the History of Modern Science. (3)
(Brush)

HIST 242. Seminar in the History of Maryland. (3)
(Van Ness)

HIST 245. Readings in Latin American History. (3)
(Griffin, Warren, Wright)

HIST 246. Seminar in Latin American History. (3)
(Griffin, Warren, Wright)

HIST 251. Seminar in Greek History. (3)
(Jashemski)

HIST 253. Seminar in Roman History. (3)
(Jashemski)

HIST 255. Readings in Medieval History. (3)
(Robertson)

HIST 256. Seminar in Medieval History. (3)
(Robertson)

HIST 259. Readings in Modern European Intellectual History. (3)
(Brann, Haber)

HIST 260. Seminar in Modern European Intellectual History. (3)
(Brann, Haber)

HIST 261. Readings in the History of the Renaissance and Reformation. (3)
(Brann, Schuessler)

HIST 262. Seminar in the History of the Renaissance and Reformation. (3)
(Brann, Schuessler)

HIST 263. Readings in the History of Great Britain and the British Empire-Commonwealth. (3)
(Gordon)

HIST 264. Seminar in the History of Great Britain and the British Empire-Commonwealth. (3)
(Gordon)

HIST 266. Seminar in Tudor and Stuart England. (3)
(Breslow)

HIST 268. Seminar in Russian History. (3)
(Yaney)

HIST 269. Readings in Nineteenth Century Europe. (3)
(Kent)

HIST 270. Seminar in Nineteenth Century Europe. (3)
(Kent)

HIST 271. Seminar in the History of World War I. (3)
(Prange)

HIST 272. Seminar in the History of World War II. (3)
(Prange)

HIST 274. Readings in Modern French History. (3)
(Greenberg)

HIST 275. Seminar in Modern French History. (3)
(Greenberg)

HIST 281. Readings in Middle Eastern History. (3)
(Shoufani, Stowasser)

HIST 282. Seminar in Middle Eastern History. (3)
(Shoufani, Stowasser)

HIST 285. Readings in Japanese History. (3)
(Mayo)

HIST 286. Seminar in Japanese History. (3)
(Mayo)

HIST 287. Readings in Chinese History. (3)
(Folsom)

HIST 288. Seminar in Chinese History. (3)
(Folsom)

HIST 290. The Teachings of History in Institutions of Higher Learning. (1) (Farrell)

HIST 399. Thesis Research. (Master's Level) (Staff)

HIST 499. Dissertation Research. (Doctoral Level) (Staff)

HOME ECONOMICS

Professors: Brooks, Prather, Shearer, and Smith.
Associate Professors: Ahrens, Brown, Butler, Dardis, Lemmon, and Wilson.
Assistant Professors: Churaman, Eheart, Olson, Spivak, and Wilbur.

The College of Home Economics offers a program in home economics leading to a Master of Science degree in each of the following major areas: food, nutrition and/or institution administration, textiles and clothing, and general home economics. Graduate programs in the Department of Family and Community Development are being initiated. Please contact College of Home Economics for information. *Home Economics Education at the graduate level is administered by the College of Education.*

Students in any of the three curricula may select from a variety of courses, seminars, and experiences in independent study. Each student plans his program in consultation with his advisory committee in accordance with the general requirements of The Graduate School and with due consideration to his purpose in undertaking graduate study.

The program in general home economics is oriented toward home economists whose work is centered in home, school and community services. It is designed primarily to increase competence in more than one area within the field of home economics. The minor area should be a coordinated program of study outside the College of Home Economics. The programs in food, nutrition and/or institution administration, and in Textiles and Clothing allow interdepartmental programs within the College.

Candidates for the master's degree are expected to have had training equivalent to that of a University of Maryland undergraduate major in the field of their choice. The Graduate Record Examination is required.

FOOD

FOOD 130. Special Problems in Foods. (2-3)
First or second semesters. Prerequisites, FOOD 152 and consent of instructor. Individual selected problems in the area of food science.

FOOD 152. Advanced Food Science. (3)
First semester. Three lectures per week. Prerequisites, CHEM 031, 033, FOOD 052, 053, CHEM 161 or concurrently. Chemical and physical properties of food as related to consumer use in the home and institutions.

FOOD 153. Experimental Food Science. (3)
Second semester. One lecture and two laboratories per week. Prerequisite, FOOD 152 or equivalent. Individual and group laboratory experimentation as an introduction to methods of food research.

FOOD 170. Economics of Food Consumption. (3)
First and second semesters. Prerequisite, Economics and consent of the instructor. Interrelations of food, population and economics progress; trends in food-consumption patterns, world and local food problems.

FOOD 180. Food Additives. (3)
Second semester, alternate years. Prerequisite, FOOD 152 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.

For Graduates

FOOD 200. 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 204. Nutritional and Quality Evaluation of Food. (3)
First semester. Prerequisite, FOOD 152 or consent of instructor. Effects of production, processing, marketing, storage, and preparation on nutritive value and quality of foods.

FOOD 210. Readings in Food. (3)
Second semester, Prerequisite, FOOD 152 or consent of instructor. A critical survey of the literature of recent developments in food research.

FOOD 220. Seminar. (1-2)
First and second semesters. Reports and discussions of current research in foods.

FOOD 240. Food Enzymes. (3)
First semester, alternate years. Two lectures and one three-hour laboratory. Prerequisite, FOOD 152 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 399. Research. (1-6)
First and second semesters. Credit in proportion to work done and results accomplished. Investigation in some phases of food which may form the basis for a thesis.

INSTITUTION ADMINISTRATION

IADM 130. Special Problems in Food Service. (2-3)
First or second semesters. Prerequisites, senior standing and consent of instructor. Individual selected problems in the area of food service.

IADM 140. Practicum in Institution Administration. (3)
Prerequisite, 5 credits in IADM and consent of department. In-service training and practical experience, totaling at least 240 hours, in an approved food service.

IADM 150. Food Service Organization and Management. (2)
First semester. Introduction to the food services; principles of organization, management, financial control, and technical operations. Records, reports, and organization charts included.

IADM 151. Quantity Food Purchasing. (3)
First semester. Prerequisite, FOOD 052, introductory accounting recommended. Food selection and the development of integrated purchasing programs. Standards of quality; the marketing distribution system; managerial cost control.

IADM 152. Quantity Food Production. (3)
Second semester. Two hours of lecture and one three-hour laboratory a week. Prerequisites, FOOD 052, 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 153. Food Service Personnel Administration. (2)
Second semester. Prerequisite, IADM 150. 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 154. School Food Service. (3)
Two lectures and one morning a week for field experience in a school food service. Prerequisite, FOOD 010, or 052, 053, and NUTR 121, or consent of instructor. Study of organization and management, menu planning, food purchasing, preparation, service, and cost control in a school lunch program.

IADM 155. Food Service Equipment and Planning. (2)
First semester. Two lectures. Prerequisite, consent of instructor. Equipment design, selection, maintenance and efficient layout; relation of the physical facility to production and service.

IADM 181, 182. Administrative Dietetics. (3, 3)
First and second semesters. (Open only to students accepted into and participating in the U.S. Army Dietetic Internship program at Walter Reed General Hospital.) Application of management theory through guided experience in all aspects of hospital dietary department administration.

IADM 183. Applied Diet Therapy. (3)
First semester. (Open only to students accepted into and participating in the U.S. Army Dietetic Internship program at Walter Reed General Hospital.) Application of principles of normal and therapeutic nutrition in the total medical care and instruction of patients.

For Graduates

IADM 200. 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 210. Readings in Food Administration. (3)
First or second semester. Reports and discussion of significant research and development in the area of food administration.

IADM 235. Computer Applications in Food Service. (3)
Second semester. Prerequisite, IADM 200 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 245. Sanitation and Safety in Food Service. (3)
Second semester. Prerequisite, MICB 001. Principles and practices of sanitation and safety unique to the production, storage and service of food in quantity; includes current legislation.

IADM 255. Experimental Quantity Food Production. (3)
First semester. Two lectures and one three-hour laboratory. Prerequisites, IADM 152 and FOOD 153 or equivalents. Application of experimental methods to quantity food production; recipe development and modification relationship of food quality to production methods.

IADM 399. 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 on a thesis.

NUTRITION

NUTR 121. Science of Nutrition. (3)
Second semester. Prerequisite, ZOOL 001, CHEM 031, 033, or concurrently. Two lectures and one two-hour laboratory. An understanding of the chemical and physiological utilization of nutrients present in food as related to individual human nutritional status, includes digestion and absorption, requirements, deficencies.

NUTR 124. Advanced Nutrition. (3)
First semester. Prerequisite, consent of department; ZOOL 001; CHEM 161, 163, or concurrent. Two lectures and one two-hour laboratory.

NUTR 125. Therapeutic Nutrition. (3)
Second semester. Two lectures and one laboratory period a week. Prerequisites, NUTR 121, 124. Modifications of the normal adequate diet to meet human nutritional needs in pathological conditions.

NUTR 130. Special Problems in Nutrition. (2-3)
First or second semesters. Prerequisite, NUTR 121 and consent of instructor. Individual selected problems in the area of human nutrition.

NUTR 140. 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 145. 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.

NUTR 150. History of Nutrition. (2)
Two lectures per week. Prerequisite, course in basic nutrition. A study of the development of nutrition and its interrelationship with social and economic developments.

For Graduates

NUTR. 208. Recent Progress in Human Nutrition. (3)
Second semester. Recent developments in the science of nutrition with emphasis on the interpretation of these findings for application in health and disease. Aids for the dietitian in creating a better understanding of nutrition among patients, students of graduate status and personnel, such as those in the dental and medical professions.

NUTR 210. Readings in Nutrition. (3)
First and second semesters. Reports and discussions of significant nutritional research and investigation.

NUTR 211. Problems in Nutrition. (3-5)
Second semester. Experience in a phase of nutrition research which is of interest to the student. Use of experimental animals, human studies or a compilation and extensive and critical study of research methods, techniques or data of specific projects.

NUTR 212. 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 220. Seminar. (1)
First and second semesters. Reports and discussion of current research in nutrition.

NUTR 221. Intermediary Metabolism in Nutrition. (3)
Second semester. Prerequisite, CHEM 161, 163 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 285. Human Nutritional Status. (3)
First semester, alternate years. Methods of appraisal of human nutritional status, to include dietary, biochemical and anthropometric techniques.

NUTR 399. Research. (Master's Level) (1-6)
First and second semesters. Credit in proportion to work done and results accomplished. Investigation in some phase of nutrition which may form the basis of a thesis.

DEPARTMENT OF FAMILY AND COMMUNITY DEVELOPMENT

For Advanced Undergraduates and Graduates

FMCD 130. Family Patterns. (3)
A study of family patterns within the sub-cultures of America and various other cultures. Emphas's will be given to those patterns and life styles which evolve as adaptations to cultural demands.

FMCD 131. Family Crises and Disintegration. (3)
Prerequisite, PSYC 001. A study of significant changes within the family setting which ultimately require major adjustments in inter-personal and intra-personal relations.

FMCD 132. The Child in the Family. (3)
First and second semesters. Three lectures. Prerequisite, PSYC 001. Study of the child from prenatal stage through adolescence, with emphasis on responsibility for guidance in the home. Biological and psychological needs as they affect the child's relationship with his family and peers.

FMCD 141. Personal and Family Finance. (3)
Study of individual and family finances with particular emphasis upon financial planning, savings, insurance, investments, income taxes and use of credit.

FMCD 143. Consumer Problems. (3)
Prerequisite, FMCD 050 or consent of instructor. Consumer practices of American families. Merchandising practices as they affect the consumer. Organizations and laws in the interest of the consumer.

FMCD 144. Resident Experience in Home Management. (3)
First and second semesters. Prerequisites, FMCD 050; 080, 141, or 143; FOOD 060; or equivalent. Residence from four to nine weeks in the home management center. Experience in planning, coordinating, and participating in the activities of a household, composed of a faculty member, a group of students, and possibly an infant on a part-time basis. Students not living in dormitories are billed at the rate of $5.00 a week for a room in the Home Management Residence. A charge of $40.00 for food and supplies is assessed each student. Dormitory residents will be refunded a prorated amount for meals.

FMCD 145. Practicum in Family and Community Development. (3)
a. Families
b. Children and Youth
c. Home Management and Consumer Studies
Planned, supervised experience of individual participation and/or observation in a community setting to relate theory to practice. Must be planned at least one semester

in advance. Planning may be facilitated by enrolling in FMCD 190 as an individual study or in EDSE 188.
Seminars once a month, or arranged.

d. Applied Home Management

This practicum is designed to increase the student's awareness and understanding of the dynamics of family resource management through experience in a home setting. Students who manage their own homes may substitute this practicum for FMCD 144. Application should be filed at time of registration one semester in advance. (Course card must indicate area of study and name of faculty member who will supervise.)

FMCD 146. Living Experiences with Families. (3-6)

a. Domestic Intercultural
b. International Intercultural

Prequisites, FMCD 080, ANTH 001, FMCD 050; 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 170. Communication Skills and Techniques in Home Economics. (3)
First and second semesters. Principles and techniques for professional demonstration and presentation of home economics and its related areas with selected experiences in television, radio, creative writing, and photography.

FMCD 180. Professional Seminar. (2)
Survey of professional opportunities, responsibilities and trends in each departmental area of emphasis. Concentration will be on the development of personal qualities and professional ethics essential for effective occupational performance.

FMCD 185. Introduction to Family Counseling. (3)
Prerequisites, PSYC 001 and 005; FMCD 005 and 131. Basic principles of counseling and its effect on family action.

FMCD 188. 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 190. Special Topics. (1-3)
Individual study or arranged group study.

a. Family studies
b. Community studies
c. Management and consumer studies

(Registration course card must indicate area of study and name of faculty member who will supervise.)

For Graduates

HOEC 201. Methods of Research in Home Economics. (3)
First and second semesters. Prerequisite, Statistics or Tests and Measurements. Application of scientific methods to problems in the field of home economics with emphasis on needed research of an inter-disciplinary nature.

HOEC 202. Integrative Aspects of Home Economics. (2)
First and second semesters. Prerequisite, consent of instructor. Scope and focus of total professional field with emphasis on purpose and functions as related to family and other group living. Impact of the changing social, economic, technological and educational situation upon home economics.

HOEC 290. Special Topics. (1-6)
Individual study or arranged group study. First and second semesters, summer session. Concentrated study in areas of home economics.

a. Housing and Applied (Art) Design
b. Clothing
c. General Home Economics
d. Family Life
e. Food and Institutional Food
f. Home Management and Consumer Studies
g. Nutrition
h. Textiles
i. Community

(Course card must indicate area of study and name of faculty member who has agreed to supervise.)

HOEC 399. Thesis Research. (1-6)
First and second semesters. Summer session. Credit according to work accomplished.

APPLIED DESIGN

APDS 120. Fashion Illustration. (3)
Three laboratory periods. Prerequisites, APDS 001, 002, 003, 010, 011. Fabric and clothing structure as they relate to illustration. Opportunity to explore rendering styles and techniques appropriate to reproduction methods currently used in advertising. Guidance in development of individuality in presentations.

APDS 121. Fashion Design and Illustration. (3)
Three laboratory periods. Prerequisite, APDS 120. Design and illustration of fashions appropriate to the custom market and to mass production.

APDS 122. Advanced Costume. (4)
Prerequisite, APDS 120 or 121. Advanced problems in fashion illustration or design. Problems chosen with consent of instructor.

APDS 130. Typography and Lettering. (3)
Three laboratory periods. Prerequisite, APDS 001, 002. Experience in hand lettering techniques as a means of understanding lettering styles in design composition. Recognition of type faces used in advertisement, book, and magazine layout. Effect of printing processes on design choices.

APDS 132. Advertising Layout. (3)
Two laboratory periods. Prerequisites, APDS 130, INED 001. Design of advertising layouts from initial idea to finished layout. Typography and illustration as the relate to reproduction processes used in direct advertising.

APDS 134, 135. Advanced Problems in Advertising Design. (3, 3)
Two laboratory periods. Prerequisite, APDS 132. Advanced problems in design and layout planned for developing competency in one or more areas of an advertising design.

APDS 136. Display Design. (3)
Three laboratory periods. Prerequisite, INED 001, APDS 130 or equivalent. Application of design principles to creative display appropriate to exhibits, design shows, merchandising. Display construction.

APDS 138. Advanced Photography. (2)
Two laboratory periods. Prerequisite, APDS 038. Composition, techniques, and lighting applicable to illustration, documentation, advertising design and display.

APDS 139. Advanced Photography. (3)
Three laboratory periods. Continuation of APDS 138.

APDS 180. Professional Seminar. (2)
Two lecture-discussion periods. Prerequisite, departmental major with junior standing. Professional and career opportunities, ethics, practices.

APDS 190. Individual Problems in Applied Design. (3-4)
(190-a—Advertising; 190-b—Costume)
Open only to advanced students who, with guidance, can work independently.

HOUSING

HSAD 140. Period Homes and Their Furnishings. (3)
Prerequisites, APDS 001, HSAD 046 or equivalent.

HSAD 141. Contemporary Developments in Architecture, Interiors, Furnishings. (3)
Prerequisite, HSAD 046 and consent of instructor.

HSAD 142. Space Development. (3)
One lecture, 2 two-hour laboratories. Prerequisites, APDS 001, 002, 003, INED 001, or equivalent. A study of blue prints and house construction as they relate to the interior designer. Development and drafting of original plans emphasizing the functional spatial relationship of furnishings to interiors.

HSAD 143. Interior Design I. (3)
One lecture-discussion, two laboratory periods. Prerequisite, APDS 010, INED 001 or equivalent. Complete presentation of rooms: isometric and perspective projections rendered in color; purchase and work orders. Emphasis on individual and family living space.

HSAD 144. Interior Design II. (3)
One lecture-discussion, two laboratory periods. Prerequisite, HSAD 143. Continuation of HSAD 143 with emphasis on commercial and contract assignments.

HSAD 145. Professional Aspects of Interior Design. (3)
One lecture plus work experience.

HSAD 146-147. Interior Design III, IV. (4, 4)
Eight hours laboratory. Prerequisite, HSAD 144. Preparation of complete presentation: work specifications, floor plans, purchase orders, renderings, etc. Portfolio preparation.

HSAD 148. Readings in Housing. (3)
Seminar. Prerequisite, SOCY 001, HSAD 041, Senior standing. To satisfy individual interests and needs, opportunity afforded for concentrated reading in one or more facets of housing (urban renewal, public housing, etc.) Examination of completed research, needed future research.

HSAD 190. Individual Study in Housing and/or Interior Design. (3-4)
Guidance for the advanced student capable of independent subject matter investigation or creative work. Problems chosen with consent of instructor.

CRAFTS

CRAF 102. Creative Crafts. (3)
Three laboratory periods. Prerequisite, CRAF 001 or CRAF 002. Problems to stimulate creative experimentation as approach to design. Work with paper, fabric, clay, wood, metal.

CRAF 120. 121. Advanced Ceramics I, Advanced Ceramics II. (3, 3)
Three laboratory periods. Prerequisite, CRAF 020.

CRAF 131. Advanced Metalry I, Advanced Metalry II. (2, 2)
Two laboratory periods. Prerequisite, CRAF 030. Advanced application of skills to design and fabrication of metals; jewelry, stone setting, metal casting, cloisonné; hand-raised hollow ware.

CRAF 140, 141. Advanced Weaving, and/or Advanced Textile Design. (2, 2)
Two laboratory periods. Prerequisites, CRAF 040, 041. Execution of original textile designs which reflect the demands both of the custom market and of mass production. Problems chosen with the consent of instructor.

CRAF 190. Individual Problems in Crafts. (3-4)
(190-a—Ceramics; 190-b—Metalry; 190-c—Textiles) Open only to advanced students who, with guidance, can work independently.

TEXTILES

For Graduates and Advanced Undergraduates

TEXT 102. Textile Science: Chemical Structure and Properties of Fibers. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, TEXT 055 and CHEM 009 or 020, 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 154. Textile Science: Finishes. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, TEXT 102 or consent of instructor. A study of the chemical reactions and mechanisms involved in imparting water repellence, crease resistance and crease recovery properties, shrink-resistance, flame resistance, soil-release properties, and moth and mildew resistance to textile materials. Properties of the finished material which 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 150. Textile Science: Chemistry and Physics of Fibers and Polymers. (3)
Two lectures and one three-hour laboratory per week. Prerequisites, consent of instructor. The theory of fiber structures and the relationship between the 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 153. History of Textiles. (3)
Three lectures per week. Prerequisites, TEXT 050 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 165. Economics of the Textile and Apparel Industries. (3)
Fall semester. Three lectures per week. Prerequisites, ECON 037 in Fall, 1970 only or ECON 031 and 032. 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.

TEXTILES AND CLOTHING

For Graduates and Advanced Undergraduates

CLTH 120. Apparel Design: Draping. (3)
Two three-hour laboratory periods per week. Prerequisites, CLTH 021 and APDS 001. Students explore pattern design through draping on the human form. Emphasis is on the interrelationships between material, design, and form.

CLTH 122. Apparel Design: Experimental Processes. (3)
Two three-hour laboratory periods per week. Prerequisites, CLTH 021, TEXT 055 and APDS 001. Processes are related to fiber and fabric characteristics, style, and end-use. Opportunities are provided for students to: 1) learn ways of tailoring by machine and by hand; 2) explore, adapt, and create new processes with modern textile materials; and 3) evaluate results in terms of design quality.

TXAP 141. Clothing and Human Behavior. (3)
Three lectures per week. Prerequisites, PSYC 001 and SOCY 001. An exploration of socio-psychological approaches to the study of clothing in relation to human behavior. Social and psychological theories will be examined as possible framework for the study and investigation of clothing.

TXCL 145. History of Costume I. (3)
Fall semester. Three lectures per week. Prerequisites, CLTH 120 and University history requirements. The Wrap-style dress. A critical study of the various forms of dress; analyzing shape and form of garments and the component parts of which they are made, taking special note of the distinctive styles and unique shapes which help distinguish one period from another; relating the history of costume to events, to achievements, to the social attitudes and development of the various times and cultures of man.

TXCL 147. History of Costume II. (3)
Spring semester. Three lectures per week. Prerequisites, same as for History of Costume I. The Shaped-style dress. A critical study of the various forms of dress; analyzing shape and form of garments and the component parts of which they are made, taking special note of the distinctive styles and unique shapes which help distinguish one period from another; relating the history of costume to events to achievements, to the social attitudes and development of the various times and cultures of man.

For Graduates

TEXT 200. Special Studies in Textiles. (2-4)
First or second semester. Summer session. Advanced inquiry into uses, care, types and/or performance of textile materials, either contemporary or historic depending on interest of students; compilation of data through testing, surveys, museum visits and/or field trips; writing of technical reports.

CLTH 220. Special Studies in Clothing. (2-4)
First or second semester. Special areas of clothing are selected according to interest of student; consumer, design, functional aspects, and/or evaluation and analysis studies are made of those areas. Reports may be written, oral, or by group presentation.

TXCL 230. Seminar. (1)
First and second semesters. The breadth and limit of the field of textiles and clothing are investigated; annotated bibliography is developed; one oral report is presented.

TXCL 232. Economics of Textiles and Clothing. (3)
Second semester. Study of interrelationship of developments in production, distribution

and consumption of textiles and clothing affecting consumers and the market. Analysis of consumption trends as related to patterns of family living and population changes.

TXCL 233. Syntheses of Behavioral Science Concepts in Textiles and Clothing. (3)
First and second semesters. Prerequisite, TXCL 126 and/or consent of department. Analysis and interpretation of interdisciplinary research methods and findings with reference to behavioral aspects of textiles and clothing. Consideration given to the measurement and relation of clothing interest and behavior to attitudes, values, roles, and social status groupings.

TXCL 399. Thesis Research. (Master's Level)
First and second semesters. A research problem is selected by the student; thesis for partial fulfillment of the Master of Science degree is written.

HORTICULTURE

Professors: Stark, Haut, Kramer, Link, Reynolds, Scott, Shanks, Thompson, Twigg, and Wiley.
Associate Professors: Angell and Stadelbacher.
Assistant Professor: Bouwkamp.
Lecturer: Borthwick.

The Department of Horticulture offers programs leading to the degrees of Master of Science and Doctor of Philosophy. Programs in *floriculture and ornamental horticulture, olericulture and pomology* are concerned with theoretical and applied work in genetics, breeding, physiology and cultural aspects of flower crops, ornamental plants, vegetable crops, and fruit crops. The program in *food science* (horticultural processing) is concerned with fundamental and applied work in the chemical, physical, bacteriological and nutritional aspects of vegetable and fruit products for processing. (See Food Science.)

Departmental requirements, supplementary to the material in *The Graduate School Announcements,* may be obtained from the Department of Horticulture.

For Graduates and Advanced Undergraduates

HORT 101. Technology of Fruits. (3)
First semester. Three lectures per week. Prerequisite, HORT 006; prerequisite or concurrent BOTN 101. (Thompson)

HORT 103. Technology of Vegetables. (3)
Second semester. Three lectures per week. Prerequisite, HORT 058; prerequisite or concurrent BOTN 101. (Reynolds)

HORT 105. Technology of Ornamentals. (3)
First semester. Three lectures per week. Prerequisite or concurrent BOTN 101. (Link)

HORT 107, 108. Woody Plant Materials. (3, 3)
First and second semesters. Prerequisite, BOTN 011. (Baker)

HORT 109. Principles of Breeding Horticultural Plants. (3)
First semester, alternate years. Three lectures per week. Prerequisite, BOTN 117 or permission of instructor. (Bouwkamp)

HORT 114. Systematic Horticulture. (3)
First semester. Two lectures and one laboratory period per week. (Angell)

HORT 161. Physiology of Maturation and Storage of Horticultural Crops. (2)
Second semester, alternate years. Two lectures per week. Prerequisite BOTN 101. Factors related to maturation and application of scientific principles to handling and storage of horticultural crops. (Scott)

HORT 162. Fundamentals of Greenhouse Crop Production. (3)
Second semester, alternate years. Three lectures per week. (Link)

HORT 163. Production and Maintenance of Woody Plants. (3)
Second semester, alternate years. Two lectures and one laboratory period a week. Prerequisite or concurrent HORT 062, 108. (Link)

HORT 207. Methods of Horticultural Research. (3)
Second semester. One lecture and one four-hour laboratory period a week. (Scott)

HORT 211. Edaphic Factors and Horticultural Plants. (3)
First semester, alternate years. Three lectures per week. Prerequisite, BOTN 101. (Reynolds)

HORT 212. Chemical Regulation of Growth of Horticultural Plants. (3)
Second semester, alternate years. Three lectures per week. Prerequisite, BOTN 101. (Shanks)

HORT 213. Environmental Factors and Horticultural Plants. (3)
First semester, alternate years. Three lectures per week. Prerequisite, BOTN 101. (Thompson)

HORT 214. Breeding of Horticultural Plants. (3)
Second semester, alternate years. Three lectures per week. Prerequisite, HORT 109 or permission of instructor. (Angell)

HORT 301. Special Problems in Horticulture. (1-3)
First and second semester. 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 program other than the student's thesis problem. Maximum credit allowed toward an advanced degree shall not exceed four hours of experimental work plus any credit obtained in a specialized lecture series.

A) Problems (Staff)
B) Physiology and Technology of Pectins (Wiley)
C) Plants and Light (Borthwick)
D) Influence of Air Pollution on the Physiology of Plants

HORT 302. Advanced Seminar. (1, 1)
First and second semesters. Three credit hours maximum allowed toward the M.S. degree or six credits maximum toward the Ph.D. degree. (Scott)

HORT 399. Masters Thesis Research. (1-12)
First and second semesters; summer session. (Staff)

HORT 499. Doctoral Dissertation Research. (1-12)
First and second semesters; summer session.

HORT S115. Truck Crop Management. (1)
Summer session only.

HORT S124. Tree and Small Fruit Management. (1)
Summer session only. (Thompson)

HORT S125. Ornamental Horticulture. (1)
Summer session only. (Link)

SPECIAL COURSES FOR TEACHERS OF VOCATIONAL AGRICULTURE

Experimental Procedures in Agricultural Sciences, see AGRI 210. (Haut, Scott)
Principles of Food Processing I, see FDSC 102. (Wiley)
Analytical Quality Control, see FDSC 112. (Kramer)
Statistical Quality Control, see FDSC 113. (Kramer)
Horticultural Products Processing, see FDSC 156. (Wiley)
Advances in Food Technology, see FDSC 201. (Kramer)
Seminar in Food Science, see FDSC 302. (Staff)

INFORMATION SYSTEMS MANAGEMENT

Professor: Patrick.
Associate Professor: Courtright.
Assistant Professors: Sprague, and Testa.
Lecturer: Golding.

The following courses are available as electives for students working toward graduate degrees in various disciplines.

For Graduates and Advanced Undergraduates

ISM 101. Electronic Data Processing. (3)
Prerequisite, junior standing, MATH 011 or the equivalent.

ISM 102. Electronic Data Processing Applications. (3)
Prerequisite, ISM 101 and BSAD 130, or consent of instructor.

ISM 103. Introduction to Systems Analysis. (3)
Prerequisites, ISM 102, BSAD 131, MATH 021 or the equivalent. Prerequisites may be waived with consent of instructor.

ISM 110. Information Processing Problems of Models of Administrative, Economic and Political Systems. (3)
Prerequisites, MATH 021 or equivalent; ISM 102, 136, BSAD 131, and some familiarity with administrative, economic and/or political models. Prerequisites may be waived with the consent of instructor.

ISM 120. Information Processing and Computational Problems in Operations Analysis. (3)
Prerequisites, MATH 021 or equivalent; ISM 102, 136 and a course in Statistics, such as BSAD 135, dealing with multivariate models. Prerequisites may be waived with the consent of the instructor.

ISM 136. Operations Research I. (3)
Prerequisite, consent of instructor. The philosophy, methods, and objectives of operations research. Basic methods are examined and their application to functional areas of business are covered.

For Graduates

ISM 210. Design of Large-Scale Information Processing Systems. (3)
Prerequisites, ISM 103 and 110, 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.

ISM 220. Management of Information Processing Systems. (3)
Prerequisite, ISM 103 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.

ISM 230. Application of Advanced Developments in Information Processing Equipment. (3)
Prerequisite, ISM 210 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.

INSTITUTE FOR FLUID DYNAMICS AND APPLIED MATHEMATICS

Research Professors and Professors: Aziz[1], Babuska, Bhatia[1], Burgers, Crane, DeClaris[2], Elsasser, Faller, Hubbard, Jones, Kellogg, Landsberg, Lashinsky, Martin, Northrup, Olver, Ortega[3], Pai, Rheinboldt[3], Tidman, Weiss[2], Wilkerson, Wu, Zwanzig[4].

Research Associate Professors and Associate Professors: Brush[5], Dorfman[6], Guernsey, Karlovitz, Koopman, Matthews, Ogilvie, Yorke.

Research Assistant Professors and Assistant Professors: Cable, Coplan, Gage, Miller, Rodenhuis, Rosenberg, Thompson, Vernekar, Zwally.

The Institute for Fluid Dynamics and Applied Mathematics is a center for applied interdisciplinary research in areas requiring combined efforts in physical and mathematical sciences, environmental sciences, and engineering. It hosts a faculty of eminent stature to promote a variety of programs, many involving members of other departments on campus and from other institutions. Its purpose is to provide graduate training for students interested in having an opportunity to perform research in a multidisciplinary environment.

The Institute faculty conducts theoretical and experimental research in meteorology, atomic physics, molecular physics, plasma physics, atmospheric physics, fluid dynamics, statistical mechanics, theoretical biophysics and geophysics, and in all areas of applied mathematics. Applied mathematicians in the Institute are currently studying topics in numerical analysis, control theory, nonlinear processes, elasticity, asympototic expansions, approximation

[1] Joint with UMBC.
[2] Joint with EE.
[3] Joint with CSC.
[4] Joint with Molecular Physics.
[5] Joint with History
[6] Joint with Physics & Astronomy.
*See the separate listing for the Meteorology Program.

theory, and in application of mathematics to the life sciences and environmental sciences. Individual research efforts are coordinated wherever possible to constitute broad programs in the atmospheric, environmental, space and life sciences. Research topics are determined entirely by the interests of students and faculty. Interdepartmental programs are strongly encouraged.

Students interested in pursuing advanced study within the Institute may be admitted to the University as graduate students in any department of engineering, or in Mathematics, Physics, or Chemistry. Those interested in meteorology may be admitted directly to the Graduate Program in Meteorology, which exists within the Institute.* Further information may be obtained by writing to the Director of the Institute for Fluid Dynamics and Applied Mathematics.

INSTITUTE FOR MOLECULAR PHYSICS

Professors: Benedict, Benesch, and Zwanzig.*
Associate Professors: De Rocco, Ginter, Krisher, Munn, Sengers, and Tilford *(Visiting, part-time).*

The Institute for Molecular Physics comprises a faculty interested in theoretical and experimental studies in the general area of molecular interactions. The Institute thus serves as an ideal place to bring together physicists and chemists to work on problems of mutual interest to the advantage of both, and the faculty is made up of members from each of these disciplines. Members of the Institute teach both undergraduate and graduate courses in both the Department of Chemistry and the Department of Physics and Astronomy and supervise thesis research of graduate students in these departments. The Department also participates in the graduate degree program in chemical physics which is jointly administered by the Institute, the Department of Chemistry, and the Department of Physics and Astronomy and is described below.

CHEMICAL PHYSICS

This program is open to graduate students in the Departments of Chemistry and Physics and Astronomy and offers a course of study leading to the degrees of Master of Science and Doctor of Philosophy. Entering students are expected to have an undergraduate degree in either chemistry or physics with a strong background in the other discipline. However, a mathematics or engineering major may also be eligible.

The following courses must be included in the major: PHYS 212 (4 credits); CHEM 323 (3) or PHYS 201 (3); CHEM 307 (3) or PHYS 208 (3); PHYS 213 (4) or CHEM 321 (3). Major electives may be from the following: CHEM 299 (3); CHEM 313 (3); PHYS 126 (3); PHYS 216 (2); PHYS 217 (2); MATH 110 (4); MATH 111 (4); MATH 114 (3). Courses to satisfy the minor may be chosen from chemistry, physics, or mathematics. Research problems in chemical physics may be supervised by the faculty in the Department of Chemistry, the Department of Physics and Astronomy or the Institute for Molecular Physics. The program is supervised by a committee from the above units.

Detailed information on this program can be obtained by writing the Chairman of the Chemical Physics Program, Institute for Molecular Physics.

*Joint appointment with the Institute for Fluid Dynamics and Applied Mathematics.

SCHOOL OF LIBRARY AND INFORMATION SERVICES

Professors: Wasserman, Reynolds, Bundy, Heilprin, and Kidd.
Associate Professors: Chisholm, Liesener, and Olson.
Assistant Professors: Colson, Donohue, Kraft, and Warner.
Lecturers: Armitage, Haro, and Hodina.
Visiting Lecturers: Soergel, Wellisch, and Wilson.
Adjunct Lecturers: Applebaum, Bougas, Costabile, Dubester, Durkin, King, LaHood, McGrath, Meadow, Sewell, and Walston.
Instructor: MacLeod.

OBJECTIVES

Reflecting the multidisciplinary nature of librarianship, the School of Library and Information Services attempts to meet the interests and needs of such specialized constituencies as the academic, technical, public and school libraries. It also recognizes a responsibility for the continuing education of professional librarians and information scientists already in practice. One sequence of study, leading to the Master of Library Science degree, includes required and elective courses (36 hours). The elective courses allow the individual to prepare himself for his chosen specialized career. The Doctor of Philosophy program was initiated to prepare men and women for careers of research and teaching in the field of library science and information services. The program requires, at minimum, the equivalent of three years of full-time study: approximately two years of formal course work (60 hours) and one year to research on the dissertation.

The Curriculum

Core Courses

LBSC 200. Introduction to Data Processing for Libraries. (3)
Systems analysis in relation to library functions and procedures. (Durkin)

LBSC 202. Introduction to Reference and Bibliography. (3)
A systematic approach to bibliographic control of recorded knowledge and the methods of securing information from various types of sources. (Haro)

LBSC 204. Communication and Libraries. (3)
Communication processes are treated and the library's role as part of the larger social context is explored. (Kidd)

LBSC 206. Organization of Knowledge in Libraries, I. (3)
Introduction to basic principles of subject cataloging, alphabetical and systematic. (Wellisch)

LBSC 207. Organization of Knowledge in Libraries, II. (3)
Introduction to basic principles of author/title and descriptive cataloging and to problems of implementation and logistics. (Wellisch)

LBSC 209. 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. (Colson)

LBSC 211. Library Administration. (3)
An introduction to administrative theory and principles and their implications and applications to manogerial activity in libraries. (Wasserman)

LBSC 213. Literature and Research in the Sciences. (3)
Bibliographic organization, information structure and trends in the direction of research in the principal scientific disciplines. (Hodina)

OR

LBSC 215. 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. (Warner)

OR

LBSC 217. Literature and Research in the Humanities. (3)
Bibliographic organization, information structure and trends in the direction of research in the principal humanistic disciplines. (McGrath)

Specialized Courses

LBSC 208. Fundamentals of Documentation. (3)
The main concern of the course is to develop an understanding of the problems inherent in information control, particularly of non-traditional forms and from non-traditional sources. (Wilson)

LBSC 210. Introduction to Information Retrieval Systems. (3)
This course considers the intellectual and physical characteristics of information and ways it may be coded, stored and retrieved. (Soergel)

LBSC 220. 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. (Olson)

LBSC 222. 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. (Chisholm, MacLeod)

LBSC 224. Construction and Maintenance of Index Languages. (3)
This course treats the making of classification schedules, subject heading lists and thesauri and those considerations relating to the revision and extension of existing ones. (Soergel)

LBSC 225. 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. (Meadow)

LBSC 226. 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. (Olson)

LBSC 227. Seminar in Documentation and Information Systems and Their Testing and Evaluation. (3)
A survey of recent developments in the processing, arrangement, and retrieval of information, and in the procedures used in their evaluation. (King)

LBSC 228. Analytical Bibliography and Descriptive Cataloging. (3)
Concentrates on the techniques and theories appropriate to the study of bibliographic morphology and bibliographical description. (Staff)

LBSC 231. 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. (Bundy)

LBSC 232. 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. (Staff)

LBSC 233. 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. (Warner)

LBSC 234. Library Systems Analysis. (3)
This course treats the principles of systems analysis, identifying the pertinent tools and techniques useful in solving the problems presented by library and special information systems. (Kraft)

LBSC 235. Problems of Special Materials. (3)
Discusses advanced principles and practices for all technical services (in particular, cataloging applicable to maps, serials, music, audio-visual items, etc. (Staff)

LBSC 237. Seminar in Research Methods and Data Analysis. (3)
An advanced seminar in research methods with emphasis upon analysis of data and hypothesis teaching. (Olson)

LBSC 244. Medical Literature. (3)
Survey and evaluation of information sources in medicine, with emphasis upon the bibliographic organization of the field. (Sewell)

LBSC 245. Legal Literature. (3)
Survey and evaluation of information sources in law, with emphasis upon the bibliographic organization of the field. (Bougas)

LBSC 246. Science Information and the Organization of Science. (3)
This seminar attempts to describe the institutional environments in which science information is produced, evaluated and disseminated. (Kidd)

LBSC 249. Seminar in Technical Services. (3)
Treatment of special administrative problems related to acquisition, cataloging and classification, circulation, and managerial controls. (Costabile)

LBSC 251. 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. (LaHood)

LBSC 253. 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. (Colson)

LBSC 255. Seminar on Manuscript Collections. (3)
Analysis of the methods and philosophy of handling special papers and documentary material in a research library. (Colson)

LBSC 258. Seminar in Information Retrieval. (3)
(Also offered as Computer Science 258) (Heilprin)

LBSC 259. Business Information Services. (3)
Survey and analysis of information sources in business, finance, and economics with emphasis upon their use in problem solving. (Wasserman)

LBSC 261. 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. (Donohue)

LBSC 263. 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. (Staff)

LBSC 264. Seminar in the School Library. (3)
Special problems in the organization and programs unique to the library of the modern school. (Liesener)

LBSC 265. Information Systems Design. (3)
A workshop oriented seminar designed to cover problems of implementation and management of various types of conventional and advanced information handling systems. (Heilprin)

LBSC 267. Advanced Organization and Administration of Libraries and Information Services. (3)
The student's theoretical understanding of organization and administration will be advanced by intensive study in the various sub-fields of contemporary library and information developments. (Bundy, Wasserman)

LBSC 268. Libraries and Information Services in the Social Process (3)
Discussion of key elements in the political and social milieu which influence the role of libraries and information service facilities in providing services. (Olson)

LBSC 269. 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. (Kidd)

LBSC 270. 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. (Staff)

LBSC 271. Advanced Reference Service. (3)
Theoretical and administrative considerations, analysis of research problems, and directed activity in bibliographic method and search techniques in large collections. (Dubester)

LBSC 273. Resources of American Libraries. (3)
Considers distribution and extent of library resources, means of surveying collections, mechanisms of inter-institutional cooperation in building collectons, and means of developing research collections in special subject fields. (Colson)

LBSC 275. Storytelling Materials and Techniques. (3)
Literary sources are studied and instruction and practice in oral techniques are offered. (MacLeod)

LBSC 277. International and Comparative Librarianship. (3)
Comparative analysis of the organization and development of libraries and their programs in different nations and cultures. (Staff)

LBSC 290. Independent Study. (1-3)
Prerequisite, consent of instructor. Designed to permit intensive individual study, reading or research in an area of specialized interest under faculty supervsion. (Staff)

LBSC 295. Special Problems in Library Science and Information Services. (3)
An examination of contemporary problems in various fields and sub-fields of library science and information services. (Staff)

LBSC 499. Thesis Research.
(Arranged)

MATHEMATICS

Professors: Auslander, Brace, Chu, Cohen, Douglis, Edmundson,† Ehrlich, Goldberg, Goldhaber, Good, L. Greenberg, Horvath, Hubbard,* Huet, Hummel, Jackson, Karp, Kleppner, Kubota, Kuroda, G. Lehner, J. Lehner, Maltese, Martin,* Mikulski, Olver,* Pearl, Reinhart, Rheinbolt,† Stellmacher, Syski, Vesentini, Walsh, Zedek.

Associate Professors: Adams, Benedetto, Bernstein, Cook, Correl, Dancis, Daniel, Goldstein, Gray, Green, Gulick, Henkelman,‡ Jacquet, Karlovitz,* Kellogg,* Kirwan, Lay, Lipsman, Lopez-Escobar, Markley, Neri, Osborn, Ortega,* Owings, Sather, Schafer, Strauss, Warner, Wolfe.

Assistant Professors: Alexander, Anderson, Berg, Connell, Cooper, Currier, Davidson,‡ Egan, Ellis, Feldman,† Fey,‡ Gowen, R. Greenberg, Helzer, Johnson, Niebur, Powell, Rastogi, D. Schneider, Shepherd, Sweet, Thaler, Unsain, Vandergraft,† Wagner, Yang, Yorke.*

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* Member of Institute for Fluid Dynamics and Applied Mathematics
† Member of Computer Science Center
‡ Joint Appointment—Department of Secondary Education
§ Joint Appointment—Department of Elementary Education

Persons interested in graduate study in mathematics should obtain from the Graduate Committee of the Department of Mathematics a booklet entitled "Departmental Policies Concerning Graduate Students," which contains detailed information concerning admission to graduate study, the requirements for the master's and doctor's degrees, the written examination, graduate student support, and other matters.

The Mathematics Department Colloquium meets frequently throughout the academic year for reports on current research by the resident staff, visiting lecturers and graduate students. In addition, the Institute for Fluid Dynamics and Applied Mathematics Colloquium meets at frequent intervals for reports on research in those fields. All colloquium meetings are open to the public. Several seminars meet regularly for the discussion of current developments in special fields. Graduate students are invited to participate.

OFF-CAMPUS COURSES—If a graduate student in mathematics wishes to have a course which is offered by University College count toward a degree, he must have prior approval from the Department of Mathematics' adviser on campus at College Park.

COURSES

Courses numbered 100-199 are open to graduate and properly qualified undergraduate students. Courses numbered 200 and above are normally open only to graduate students.

COURSES IN ALGEBRA:
100, 101, 103, 104, 106, 107, 200, 201, 202, 203, 206, 207, 208, 209, 227, 228, 271.

COURSES IN ANALYSIS:
110, 113, 114, 117, 118, 119, 165, 204, 205, 212, 215, 216, 218, 219, 265, 266, 272, 278, 280, 281, 282, 283, 286, 287, 288, 289, 294, 295.

COURES IN GEOMETRY AND TOPOLOGY:
120, 121, 122, 123, 124, 126, 128, 221, 222, 223, 224, 225, 226, 227, 228, 229, 273, 290, 291, 296.

COURSES IN APPLIED AND NUMERICAL MATHEMATICS:
101, 114, 162, 163, 164, 165, 168, 170, 171, 215, 216, 250, 251, 252, 255, 256, 259, 261, 262, 263, 264, 265, 266, 267, 268, 269, 274, 282, 283, 294, 295.

COURSES IN PROBABILITY AND STATISTICS:
Stat 100, 101, 110, 111, 120, 121, 150, 164, 170, 200, 201, 210, 212, 213, 220, 221, 222, 223, 240, 241, 250, 275, 276.

COURSES IN LOGIC AND FOUNDATIONS:
144, 146, 147, 148, 240, 244, 277.

COURSES FOR TEACHERS OF MATHEMATICS AND SCIENCE:
181, 182, 183, 184, 185, 189.

SEMINARS AND RESEARCH:
190, 191, 298, 399, 499.

MATH 100. Vectors and Matrices. (3)
Prerequisite, MATH 021 or MATH 015. Algebra of vector spaces and matrices. Recommended for students interested in the applications of mathematics. Graduate students majoring in Mathematics cannot take this course for credit.

MATH 101. Applied Linear Algebra. (3)
Prerequisite, MATH 100 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 103. Introduction to Abstract Algebra. (3)
Prerequisite, MATH 022, or equivalent. Integers, groups, rings, integral domains, fields.

MATH 104. Introduction to Linear Algebra. (3)
Prerequisite, MATH 103 or consent of instructor. An abstract treatment of finite-dimensional vector spaces. Linear transformations and their invariants.

MATH 106. Introduction to Number Theory. (3)
Prerequisite, MATH 022. Rational integers, divisibility, prime numbers, modules and linear forms, unique factorization theorem, Euler's function, Mobius' function, cyclo-otmic 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 107. Theory of Quadratic Number Fields. (3)
Prerequisites, MATH 106 and MATH 103. Quadratic number fields, integers, ideals,

units, ideal class groups, unimodular transformations and algorithms of the determination of ideal class groups and fundamental units, class number formula, Gauss' theory of genera and Kronecker's symbol.

MATH 110. Advanced Calculus. (3)
Prerequisite, MATH 022. Real number system, topology of the real line, limits and continuity of real valued functions of one real variable, differentiation, functions of bounded variation, Riemann-Stieltjes integration, sequences and series of functions.

MATH 113. Introduction to Complex Variables. (3)
Prerequisite, MATH 110. 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 113 and MATH 163.)

MATH 114. Differential Equations. (3)
Prerequisite, MATH 110. A general introduction to the theory of differential equations. Constructive methods of solution leading to existence theorems and uniqueness theorems. Other topics such as: systems of linear equations, the behavior of solutions in the large, the behavior of solutions near singularities, periodic solutions, stability and Sturm-Liouville problems.

MATH 117. Introduction to Fourier Analysis. (3)
Prerequisite, MATH 113. Fourier series. Fourier and Laplace transforms.

MATH 118. Introduction to Real Variables. (3)
Prerequisite, MATH 110. The Lebesgue integral. Fubini's theorem. Convergence theorems. The Lp spaces.

MATH 119. Several Real Variables. (3)
Prerequisite, MATH 110. A brief review of scalar and vector-valued functions of several real variables (as done in MATH 022). Implicit function theorem, change of variables theorem for multiple integrals, a detailed study of surfaces and surface integrals in n-dimensional Euclidean space. Applications to partial differential equations and potential theory.

MATH 120. Introduction to Geometry I. (3)
Prerequisite, MATH 022 or consent of instructor. Axiomatic development of plane geometries, Euclidean and non-Euclidean. Groups of isometries and similarities.

MATH 121. Introduction to Geometry II. (3)
Prerequisite, MATH 120. Non-Euclidean transformation groups, the Erlangen program, projective planes, cubics and quartics.

MATH 122. Introduction to Point Set Topology. (3)
Prerequisite, MATH 110 or 146, or equivalent. Connectedness, compactness, continuous maps, homeomorphisms; applications to the Euclidean plane.

MATH 123. Introduction to Algebraic Topology. (3)
Prerequisite, MATH 122 and 103, or equivalent. Chains, cycles, homology groups for surfaces, the fundamental group, covering spaces.

MATH 124. Introduction to Projective Geometry. (3)
Prerequisite, MATH 022 or equivalent. Recommended for students in the College of Education. Elementary projective geometry, combining synthetic algebraic approaches, projective transformations, harmonic division, cross ratio, projective coordinates, properties of conics.

MATH 126. Introduction to Differential Geometry. (3)
Prerequisite, MATH 022 or equivalent. The differential geometry of curves and surfaces, curvature and torsion, moving frames, the fundamental differential forms, intrinsic geometry of a surface, the Gauss-Bonnet theorem.

MATH 128. Euclidean Geometry. (3)
Prerequisite, MATH 021 or consent of instructor. Recommended for students in the College of Education. Axiomatic method, models, properties of axioms; proofs of some basic theorems from the axioms; modern geometry of the triangle, circle, and sphere.

MATH 144. Elementary Logic and Algorithms. (3)
Prerequisite, MATH 021 or consent of instructor. This is the same course as CMSC 144. An elementary development of propositional logic, predicate logic, set algebra, and Boolean algebra, with a discussion of Markov algorithms, Turing mochines and recursive functions. Topics include Post productions, word problems and formal languoge.

MATH 146. Fundamental Concepts of Mathematics. (3)
Prerequisite, MATH 021 or consent of instructor. Sets, relations, mappings. Construction of the real number system starting with Peano postulates; algebraic structures associated with the construction; Archimedean order, sequential completeness and equivalent properties of ordered fields. Finite and infinite sets, denumerable and non-denumerable sets.

MATH 147. Axiomatic Set Theory. (3)
Prerequisite, MATH 103 or 146 or consent of instructor. Development of a system of axiomatic set theory, choice principles, induction principles, ordinal arithmetic including discussion of cancellation laws, divisibility, canonical expansions, cardinal arithmetic including connections with the axiom of choice, Hartog's Theorem, König's Theorem, properties of regular, singular, and inaccessible cardinals.

MATH 148. Introduction to Mathematical Logic. (3)
Prerequisite, MATH 103 or 146 or 110. Formal propositional logic, completeness, independence, decidability of the system, formal quantificational logic, first-order axiomatic theories, extended Gödel Completeness Theorem, Lowenheim-Skolem Theorem, model-theoretical applications.

MATH 162. Analysis for Scientists and Engineers I. (3)
Prerequisite, MATH 021 or consent of instructor. Not open to students with credit for MATH 022. Calculus of functions of several real variables; limits, continuity, partial differentiation, multiple integrals, line and surface integrals, vector-valued functions, theorems of Green, Gauss and Stokes, physical applications. (This course cannot be counted toward a major in mathematics.)

MATH 163. Analysis for Scientists and Engineers II. (3)
Prerequisite, MATH 162 or 022 or consent of instructor. Not open to students with credit for MATH 113. The complex field. Infinite processes for real and complex numbers. Calculus of complex functions. Analytic functions and analytic continuation. Theory of residues and application to evaluation of integrals. Conformal mapping. (This course cannot be counted toward a major in mathematics.)

MATH 164. Analysis for Scientists and Engineers III. (3)
Prerequisite, MATH 066 and MATH 163, or consent of instructor. Fourier and Laplace transforms. Evaluation of the complex inversion integral by the theory of residues. Applications to systems of ordinary and partial differential equations. (This course cannot be counted toward a major in mathematics.)

MATH 165. Introduction to Partial Differential Equations. (3)
Prerequisite, MATH 110 or MATH 162. Topics will include one dimensional wave equation; linear second order equations in two variables; separation of variables and Fourier series; Sturm-Liouville Theory.

MATH 168. Numerical Methods for Scientists and Engineers. (3)
Prerequisite, MATH 022 or 162 and MATH 066. Interpolation, numerical differentiation and integration, numerical solution of polynomial and transcendental equations, least squares, systems of linear equations, numerical solution of ordinary differential eqauations, errors in numerical calculations. (This course cannot be counted toward a major in mathematics.

MATH 170. Numerical Analysis I. (3)
Prerequisite, MATH 110 (or concurrent registration). A thorough treatment of solutions of equations, interpolation and approximation, numerical differentiation and integration, numerical solution of initial value problems in the solutions of ordinary differential equations.

MATH 171. Numerical Analysis II. (3)
Prerequisite, MATH 100 or 104 and MATH 110 (or concurrent registration). The solution of linear systems by direct and iterative methods, matrix inversion, the evaluation of determinants, eigenvalues and eigenvectors of matrices. Application to boundary value problems in ordinary differential equations. Introduction to the numerical solution of partial differential equations.

MATH 181. Introduction to Number Theory. (3)
Prerequisite, one year of college mathematics or consent of instructor. Designed primarily for those enrolled in programs with emphasis in the teaching of mathematics and science. Not open to students seeking a major directly in the physical sciences, since the course content is usually covered elsewhere in their curriculum. Axiomatic development of the real numbers. Elementary number theory.

MATH 182. Introduction to Algebra. (3)
Prerequisite, one year of college mathematics or consent of instructor. Designed primarily for those enrolled in programs with emphasis in the teaching of mathematics and science. Not open to students seeking a major directly in the physical sciences, since the course content is usually covered elsewhere in their curriculum. Modern ideas in algebra and topics in the theory of equations.

MATH 183. Introduction to Geometry. (3)
Prerequisite, one year of college mathematics or consent of instructor. Designed primarily for those enrolled in programs with emphasis in the teaching of mathematics and science. Not open to students seeking a major directly in the physical sciences, since the course content is usually covered elsewhere in their curriculum. A study of the axioms for Euclidean and non-Euclidean geometry.

MATH 184. Introduction to Analysis. (3)
Prerequisite, one year of college mathematics or consent of instructor. Designed primarily for those enrolled in programs with emphasis in the teaching of mathematics and science. Not open to students seeking a major directly in the physical sciences, since the course content is usually covered elsewhere in their curriculum. A study of the limit concept and the calculus. (Previous knowledge of calculus is not required).

MATH 185. Selected Topics for Teachers of Mathematics. (1-3)
Prerequisite, one year of college mathematics or consent of instructor.

MATH 189. 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 a

logical discipline and as a medium of expression. Special emphasis on topics relevant to current mathematical curriculum studies and revisions.

MATH 190. Honors Seminar. (2)
Prerequisite, permission of the departmental Honors Committee. Reports by students on mathematical literature; solution of various problems.

MATH 191. Selected Topics in Mathematics. (Variable credit)
Prerequisite, permission of the instructor. Topics of special interest to advanced undergraduate students will be offered occasionally under the general guidance of the departmental Committee on Undergraduate Studies. Honors students register for reading courses under this number.

STAT 100. Applied Probability and Statistics I. (3)
Prerequisite, MATH 15 or MATH 20. Random variables, common distributions, moments. Law of large numbers and central limit theorem. Sampling methods, estimation of parameters, testing of hypotheses, analysis of variance, regression and correlation.

STAT 101. Applied Probability and Statistics II. (3)
Prerequisite, STAT 100 (Math 021 recommended). Point estimation, sufficient, unbiased, and consistent estimators. Minimum variance and maximum likelihood estimators. Interval estimation. Testing of hypotheses. Regression and linear hypotheses. Sampling distributions. Experimental designs. Sequential tests, elements of nonparametric methods.

STAT 110. Introduction to Probability Theory. (3)
Prerequisite, MATH 022. Probability space and basic properties of probability measure. Random variables and their distribution functions, induced probability spaces. Multidimensional distribution functions. Characterstic functions. Limit theorems.

STAT 111. Introduction to Stochastic Processes. (3)
Prerequisite, STAT 100 or STAT 110. Elementary stochastic processes. Renewal process, random walks, branching process, discrete Markov chains, first passage times. Markov chains with a continuous parameter, birth and death processes. Stationary processes and their spectral properties.

STAT 120. Introduction to Statistics I. (3)
Prerequisite, STAT 101 or STAT 110. Short review of probability concepts including sampling distributions. Interval estimation. Theory of order statistics. Tolerance limits. Limit distributions and stochastic convergence. Sufficient statistics. Completeness and stochastic independence. Rao-Blackwell Theorem.

STAT 121. Introduction to Statistics II. (3)
Prerequisite, STAT 120. Loss and risk functions. Statistical decisions. Optimality criteria. Uniformly minimum risk procedures. Bayesian risk, minimax principle. Point estimation theory. Statistical hypotheses and optimal tests. Likelihood ratio tests. Elements of linear hypotheses, analysis of variance and sequential theory.

STAT 150. Regression and Variance Analysis. (3)
Prerequisite, STAT 101 or STAT 120. One, two, three, and four way layouts in analysis of variance fixed effects models, linear regression in several variables, Gauss-Markov Theorem, multiple regression analysis, experimental designs.

STAT 164. Introduction to Biostatistics. (3)
Prerequisite, one semester of calculus and junior standing. Probabilistic models. Sampling. Some applications of probability in genetics. Experimental designs. Estimation of effects of treatment. Comparative experiments. Fisher-Irwin test. Wilcoxon

tests for paired comparisons. (This course cannot be counted toward a major in mathematics.)

STAT 170. Linear and Nonlinear Programming. (3)
Prerequiste, MATH 021 or MATH 100. Duality theorem and minimax theorem for finite matrix games. Structure of linear and nonlinear solutions with perturbations. Various solution techniques of linear, quadratic, and convex programming methods. Special integer programming models (transportation and traveling salesman problems). Network theory with max-flow-min-cut theorem.

MATH 200. Abstract Algebra I. (3)
Prerequisite, MATH 104 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 201. Abstract Algebra II. (3)
Prerequisite, MATH 200 or consent of instructor. Field theory, Galois theory, Multilinear algebra. Further topics from: Dedekind domains, Noetherian domains, rings with minimum condition, homological algebra.

MATH 202. Homological Algebra. (3)
Prerequisite, MATH 200. Projective and injective modules, homological dimensions, derived functors, sprectral sequence of a composite functor. Applications.

MATH 203. Commutative Algebra. (3)
Prerequisite, MATH 200. Ideal theory of Noetherian rings, valuations, localizations, complete local rings, Dedekind domains.

MATH 204, 205. Topological Groups. (3, 3)
Prerequisites, MATH 286, and MATH 289 or MATH 225, or consent of instructor. General nature or topological groups including homomorphism theorems, Haar measure, representations of compact groups and the Peter-Weyl Theorem, Pontrjagin duality and the Plancherel Theorem.

MATH 206. Algebraic Number Theory I. (3)
Prerequisites, MATH 201, or consent of instructor. Alegbraic numbers and algebraic 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 207. Algebraic Number Theory II. (3)
Prerequisites, MATH 206, MATH 200 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 208. Ring Theory. (3)
Prerequisite, MATH 201 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 209. Group Theory. (3)
Prerequisite, MATH 201 or consent of instructor. Topics selected from the following: finite groups, abelian groups, free groups, solvable or nilpotent groups, groups with operators, groups with local properties, groups with clan conditions, extensions.

MATH 212. Special Functions. (3)
Prerequisite, MATH 287 or consent of instructor. Gamma-function, Riemann zeta-function, hypergeometric functions, confluent hypergeometric functions, Bessel functions.

MATH 215, 216. Advanced Ordinary Differential Equations. (3, 3)
Prerequisites, MATH 286 and either MATH 100 or MATH 104. Existence and uniqueness theorems for systems of differential equations, linear theory, properties of solutions of differential equations including stability, asymptotic behavior, oscillation and comparison theorems. Plane autonomous systems. Non-linear systems. Topics of current interest.

MATH 218, 219. Functional Analysis. (3, 3)
Prerequisites, MATH 286, 287. Normed linear spaces including Banach and Hilbert spaces, linear operators and their spectral analysis, with application to differential and integral equations.

MATH 221. Differentiable Manifolds. (3)
Prerequisite, consent of instructor. Differentiable manifolds, embeddings in Euclidean space, vector and tensor bundles, vector fields, differentiable fields. Riemann metrics.

MATH 222. Differential Geometry. (3)
Prerequisite, MATH 221, or consent of instructor. Connections, curvature, torsion, symplectic contact, and complex structures.

MATH 223, 224. Algebraic Topology. (3, 3)
Prerequisite, MATH 226. First semester: Singular homology, uniqueness theorems, tensor products and homomorphisms, the functors ext and tor, universal coefficient theorems, Künneth and Eilenberg-Zilber theorems, products and duality. Second semester: Higher homotopy groups. CW complexes, obstruction theory, Eilenberg-MacLane spaces, the Serre spectral sequences.

MATH 225. Topology I. (3)
Prerequisite, MATH 110. Topological spaces, continuous maps, homeomorphisms. Product and quotient spaces. Existence of real-valued functions. Metric and metrizable spaces.

MATH 226. Topology II. (3)
Prerequisite, MATH 225, some familiarity with abstract algebra. Spaces of mappings, fundamental group, covering spaces. Finite simplicial complexes and simplicial mappings. Simplicial homology theory. Fixed point theorems.

MATH 227, 228. Algebraic Geometry. (3, 3)
Prerequisite, consent of instructor. Prime and primary ideals in Noetherian rings, Hilbert Nullstellensatz, places and valuations, fields of definitions, Chow points, birational correspondences, Abelian varieties, Picard varieties, algebraic groups.

MATH 229. Differential Topology. (3)
Prerequisite, MATH 221. Characteristic classes, cobordism, differential structures on cells and spheres.

MATH 240. Consistency Proofs in Set Theory. (3)
Prerequisites, MATH 147 and 148. Consistency and independence of such fundamental principles of set theory as the laws of choice, of cardinal arithmetic of constructibility and regularity. Gödel's model of constructible sets, inner models, Cohen's generic models.

MATH 244. Mathematical Logic. (3)
Prerequisite, MATH 148. Completeness of first-order predicate logic and applications, recursive functions, Godel's incompleteness theorem.

MATH 250. Eigenvalue and Boundary Value Problems I. (3)
Prerequisites, MATH 104 and 110. Linear analysis and applications to modern applied mathematics. The central theme of the course will be the theory of compact operators on Hilbert space and its application to integral equations and eigenvalue and boundary value problems for ordinary differential equations.

MATH 251. Eigenvalue and Boundary Value Problems II. (3)
Prerequisite, MATH 250. Asymptotic behavior of eigenvalues and eigenfunctions for second-order ordinary and partial differential equations. Variational formulation of boundary value problems. Upper and lower bounds for eigenvalues. Isoperimetric inequaliities.

MATH 252. 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 255. Numerical Methods in Ordinary Differential Equations. (3)
Prerequisites, MATH 104 and 114. Discrete variable methods for solving initial value and boundary value problems in ordinary differential equations. Stability Theory.

MATH 256. Numerical Methods in Partial Differential Equations. (3)
Prerequisites, MATH 104 and 265. Approximation methods for boundary value, initial value, and eigenvalue problems in partial differential equations, including finite differences and methods involving approximating functions.

MATH 259. Introduction to Continuum Mechanics. (3)
Prerequisite, consent of instructor. Solid and fluid continua, general analysis of stress and strain, equilibrium of elastic bodies, equations of motion for fluid bodies, stress-strain relations, equations of perfect fluids and formulation of viscous flow problems.

MATH 261, 262. Fluid Dynamics. (3, 3)
Prerequisite, consent of instructor. A mathematical formulation and treatment of problems arising in the theory of incompressible, compressible and viscous fluids.

MATH 263. Linear Elasticity. (3)
Prerequisite, MATH 259. 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 264. Non-Linear Elasticity. (3)
Prerequisite, MATH 259. Fundamentals of non-linear elasticity, finite deformations, rubber elasticity, small deformations superimposed on finite deformations.

MATH 265. Partial Differential Equations I. (3)
Prerequisite, MATH 119 or consent of instructor. Gauss and Green formulas, the Cauchy problem for the wave equation, method of descent and Huygens principle. The Dirichlet and Neumann problem for the Laplace equation, single and double layer potentials, Green's functions, the method of integral equations.

MATH 266. Partial Differential Equations II. (3)
Prerequisite, MATH 265. Introduction to modern theories in partial differential equations. Topics include: existence and uniqueness questions, concepts of weak and strong solutions, applications of functional analysis.

MATH 267. Advanced Linear Numerical Analysis. (3)
Prerequisites, MATH 104 and 250. Numerical methods for solving linear systems with an emphasis on error analysis, iterative methods for large systems. The numerical solution of the algebraic eigenvalue problem.

MATH 268. Advanced Nonlinear Numerical Analysis. (3)
Prerequisites, MATH 286 and 250. Iterative solution of nonlinear operation equations, in particular, nonlinear systems. Existence questions. Minimization methods and applications to approximation problems.

MATH 269. Advanced Mathematical Programming. (3)
Prerequisites, STAT 111 and STAT 170 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 271. Selected Topics in Algebra. (3)
Prerequisite, consent of instructor.

MATH 272. Selected Topics in Analysis. (3)
Prerequisite, consent of instructor.

MATH 273. Selected Topics in Geometry and Topology. (3)
Prerequisite, consent of instructor.

MATH 274. Selected Topics in Applied Mathematics. (3)
Prerequisite, consent of instructor.

MATH 277. Selected Topics in Mathematical Logic. (3)
Prerequisite, consent of instructor.

MATH 278. Advanced Topics in Complex Analysis. (3)
Prerequisite, consent of instructor.

MATH 280, 281. Linear Spaces. (3, 3)
Prerequisite, MATH 218. Linear topological spaces, locally convex spaces, duality theory, distributions.

MATH 282, 283. Interpolation and Approximation. (3, 3)
Prerequisite, MATH 286, 287 or consent of instructor. First semester: Possibility of approximation by polynomials in the complex domain. Lemniscates. Interpolation by polynomials. Maximal convergence. Uniform distribution of points. Interpolation and approximation by rational functions. Rational functions with some free poles.
Second semester: Interpolation of real functions and remainder theory. Uniform and least square approximations. Chebyshev oscillation theorems. Orthogonal polynomials. Degree of approximation. Abstract formulation of approximation theory. Constructive function theory.

MATH 286. Real Analysis I. (3)
Prerequisite, MATH 110 or equivalent. Lebesgue measure and integration on the line. Differentiation, absolute continuity, L^p spaces, Fubini's theorem. If time permits, some applications to Fourier series and transforms.

MATH 287. Complex Analysis I. (3)
Prerequisite, MATH 110 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 288. Complex Analysis II. (3)
Prerequisites, MATH 286, 287. Topics in conformal mappings, normal families, Picard's theorem, classes of univalent functions, extremal properties, variational methods, elliptic functions, Riemann surfaces.

MATH 289. Real Analysis II. (3)
Prerequisite, MATH 286. Set functions and integration in general measure spaces, Lebesgue spaces, representation of bounded linear functionals on L^p, spaces of measures, Radon-Nikodym theorem, product measure spaces (Fubini and Tonelli theorems), differentiation of set functions, Riesz representation theorem. Selected topics, e.g., harmonic analysis, vector-valued measure, product measure of infinitely many measure spaces.

MATH 290, 291. Lie Groups. (3, 3)
Prerequisites, MATH 103, 104, 119 and 122, their equivalents, or consent of instructor. Some of the following topics will be emphasized: groups of matrices, solvable Lie groups, compact Lie groups, classification of semi-simple Lie groups, representation theory, homogeneous spaces.

MATH 294, 295. Advanced Classical Analysis. (3, 3)
Prerequisite, MATH 113. A basic course in those parts of analysis essential for applied mathematics. Topics covered: Fourier series and integrals, integral transforms, asymptotic series, special functions.

MATH 296. Point Set Topology. (3)
Prerequisite, MATH 225. 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 298. Proseminar in Research. (1)
Prerequisite, one semester of graduate work in mathematics. A seminar devoted to the foundations of mathematics, including mathematical logic, axiom systems, and set theory.

MATH 399. Thesis Research. (Master's Level)
Arranged.

MATH 499. Dissertation Research. (Doctoral Level)
Arranged.

STAT 200. Probability Theory I. (3)
Prerequisite, STAT 110 or MATH 110 with one semester of Probability. Probability space, classes of events, construction of probability measures. Random variables, convergence theorems, images of measures. Independence. Expectation and moments, Lebesgue integration, L^p spaces, Radon-Nikodym theorem, singular and absolutely continuous measures. Conditional expectations, existence of regular distributions; applications. Probabilities on product spaces, Fubini theorem, Kolmogorov extension theorem, Tulcea product theorem.

STAT 201. Probability Theory II. (3)
Prerequisite, STAT 200, MATH 113 recommended. Characteristic functions of distribution 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. Law of the iterated logarithm. Arc sine law. Central limit theorems for independent and dependent random variables (Lindeberg-Feller theorem). Weak and strong laws of large numbers. Martingale convergence theorems (for sequences).

STAT 210. Applied Stochastic Processes. (3)
Prerequisite, STAT 110 or MATH 110 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 parameter). Birth and death processes, diffusion processes. Applications from theories of queueing, storage, inventory, epidemics, noise, prediction, and others.

STAT 212. Stochastic Processes I. (3)
Prerequisite, STAT 201. Separability, measurability, and sample continuity of stochastic processes. Stopping times. Martingales: fundamental inequalities, convergence theorems and their applications, continuity theorems, martingale times, sample function behavior. Processes with independent (orthogonal) increments, Brownian motion. Stationary processes, spectral analysis, and ergodic theory.

STAT 213. Stochastic Processes II. (3)
Prerequisite, STAT 201. Definition and classification of Markov processes. Properties of transition probabilities, forward and backward equations (boundary conditions), absorption probabilities, strong Markov-property. Markovian semigroups, extended infinitesimal operator. Sample function behavior. Connections between semigroup approach and sample function approach. Diffusion theory. Ito equation. Potential theory.

STAT 220. Mathematical Statistics I. (3)
Prerequisite, STAT 110, or STAT 101 and MATH 110, or equivalent. Special distributions, expectations, moments, characteristic functions. Multivariate distributions, sampling distributions, limit theorems. Transformations, order statistics, series representations. Estimation, Cramer-Rao inequality, maximum likelihood. Gauss-Markov theorem, and Bayes estimates.

STAT 221. Mathematical Statistics II. (3)
Prerequisite, STAT 220 or STAT 120. Tests of hypotheses, Neyman-Pearson lemma, and likelihood ratio tests. Bayesian inference. Goodness-of-fit and contingency tables. Regression and analysis of variance. Non-parametric tests, sequential analysis, multivariate analysis.

STAT 222. Advanced Statistics I. (3)
Prerequisite, STAT 121, concurrent registration with STAT 200 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 223. Advanced Statistics II. (3)
Prerequisite, STAT 222. 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 Hunti-Stein theorem.

STAT 240. Multivariate Analysis. (3)
Prerequisite, STAT 120 and MATH 100, or STAT 220. 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 241. Sampling Theory. (3)
Prerequisite, STAT 120 or STAT 220. Simple random sampling. Sampling for proportions. Estimation of sample size. Sampling with varying probabilities of sampling. Sampling: stratified, systematic cluster, double, sequential, incomplete.

STAT 250. Nonparametric Statistics. (3)
Prerequisite, STAT 222. Order statistics. Nonparametric point and set estimation. Stochastic approximation. Tolerence regions. Invariance principle and its applications. Large sample properties and optimality criteria, efficacy, Pitmann efficiency. Rank tests and Kolmogorov-Smirnov type tests. U-statistic.

STAT 270. Selected Topics in Probability. (3)
Prerequisite, consent of instructor.

STAT 275. Selected Topics in Statistics. (3)
Prerequisite, consent of instructor

MECHANICAL ENGINEERING

Professors: Allen, Armstrong, Asimow, Berger, Cunniff, Jackson, John, Marcinkowski, Sayre, Shreeve, Talaat, and Weske.
Associate Professors: Anand, Fourney, Hayleck, Marks, Sallet, Walston, Wockenfuss, and Yang.
Assistant Professors: Buckley, Elkins, Forsnes, Hill, Morse, and Tsui.
Lecturers: Dawson, Haberman and Seigel.

Instruction and research facilities are available for the degrees of Master of Science and Doctor of Philosophy in mechanical engineering.

For the Master of Science degree in mechanical engineering a minimum of six semester hours of course work in mechanical engineering must be taken in classes conducted by members of the resident graduate faculty. For the Doctor of Philosophy degree, the minimum is 18 semester hours.

Registration for six credits of research (ENME 399, Research) for the master's degree and 18 credits (ENME 499) for the doctoral degree are required. It is the policy of the Department to require that this research be conducted in the Department laboratories. Arrangements for the research and for faculty supervision must be made, and approved by the Department chairman, well in advance of the registration for the research in order that the funds and equipment may be made available. A non-thesis master's degree may also be obtained with the consent of the Department.

In the Mechanical Engineering Department there are five main divisions of specialization. These include design and systems analysis; energy; fluid mechanics; materials; and solid mechanics. A student may major in one of these fields with a minor in one or more of the others. Opportunities are also available for a student to take advanced work in industrial engineering and operations research (under design and systems analysis), marine engineering (under fluid mechanics) or bio-mechanical engineering (under energy conversion).

The materials courses are listed under a separate heading in this catalog.

Students planning graduate work should preferably choose electives to provide the best background for their main areas of interest. These areas of current specialization and research include:

I DESIGN AND SYSTEMS ANALYSIS

A. Mechanical Engineering Design
B. Controls Systems Analysis

II ENERGY

A. Thermodynamics
B. Heat Transfer
C. Energy Conversion

III FLUID MECHANICS

A. Incompressible Flow
B. Compressible Flow
C. Viscous Flow
D. Unsteady Hydrodynamics

IV SOLID MECHANICS

A. Dynamics
B. Continuum Mechanics
C. Elasticity; Linear and Non-linear
D. Stress Waves
E. Vibrations; Linear, Non-linear
F. Plasticity
G. Viscoelasticity
H. Shells; Linear and Non-linear

V MATERIALS

See listing under Materials section.

For Advanced Undergraduates and Graduates

DESIGN AND SYSTEMS ANALYSIS

ENME 103. Materials Engineering. (3)
Two lectures and one laboratory period a week. Prerequisite, ENES 30. Processes and methods to manufacture and usefully apply engineering matrials, alloys and heat treatment of steel, strengthening processes for ferrous and non-ferrous alloys. Fabrication techniques for metals, polymers, and refractories. Specification, inspection, control and automation.

ENME 152. Machine Design. (3)
Two lectures and one laboratory period a week. Prerequisites, ENME 101, 103. Working stresses, stress concentration, stress analysis and repeated loadings. Design of machine elements. Kinematics of mechanisms.

ENME 156, 157. Mechanical Engineering Analysis and Design. (3, 4)
First semester, two lectures, one laboratory period per week, second semester, two lectures and two laboratory periods per week. Prerequisite, senior standing in mechanical engineering. Creative engineering and problem analysis. Systems design including control reliability and manufacturing requirements. Use of computers in design. Design of multi-variable systems.

ENME 165. Automatic Controls. (3)
Three lectures per week. Prerequisites, ENEE 62, 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 167. Operations Research I. (3)
Three lectures a week. Prerequisite, senior standing in mechanical engineering. Applications of linear programming, queuing model, theory of games and competitive models to engineering problems.

ENME 168. Introduction to Industrial Engineering. (3)
Three lectures per week. Prerequisite, ENME 103 and ECON 37 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.

ENERGY CONVERSION

ENME 100. Thermodynamics. (3)
Two lectures and one laboratory period a week. Prerequisites, PHYSICS 031, MATH 21. The properties, characteristics and fundamental equations of gases, and vapors. Application of the first and second laws of thermodynamics in the analysis of basic heat engines, air compression, and vapor cycles. Flow and non-flow processes for gases and vapors.

ENME 106. Transfer Processes. (3)
Three lectures a week. Prerequisite, ENME 102. Conduction by steady state and variable heat flow, laminar and turbulent flow, free and forced convection, radiation, evaporation and condensation of vapors. Transfer of mass, heat, and momentum.

ENME 107. Energy Conversion. (3)
Three lectures a week. Prerequistie, ENME 100. 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 150, 151. Energy Conversion. (4, 3)
First semester. Three lectures, one laboratory a week. Second semester. Two lectures, one laboratory a week. Prerequisites, ENME 104, ENME 106. Chemical, heat, mechanical, nuclear and electrical energy conversion processes, cycles and systems. Reciprocating, turbo-and jet-propulsion power plants and components using all types of heat and reaction sources. Direct conversion processes of fuel cells, thermionics and magnetohydromechanics.

ENME 161. Environmental Engineering. (3)
Three lectures a week. Prerequisites, ENME 101, 106, 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 164. Thermodynamics II. (3)
Three lectures a week. Prerequisites, ENME 104, ENME 106, senior standing. Applications to special systems, change of phase, low temperature. Statistical concepts, equilibrium, heterogenous systems.

FLUID MECHANICS

ENME 102. Fluid Mechanics I. (3)
Two lectures and one laboratory period a week. Prerequisite, ENME 60. A rational

study of fluids at rest and in motion. Principles of viscous and turbulent flow in pipes, nozzles, etc. Impluse and momentum. Pumps, turbines, and meters. Dimensional analysis and laws of similarity.

ENME 104. Gas Dynamics. (3)
Two lectures and one laboratory period a week. Prerequisite, ENME 102. Compressible flow in ducts and nozzles, effect of area change, heat addition, friction, and normal shocks. Thermodynamics of chemically reacting flows, combustion and equilibrium.

ENME 163. Fluid Dynamics II. (3)
Three lectures a week. Prerequisites, ENME 104, ENME 106, senior standing. Hydrodynamics with engineering applications. Stream function and velocity potential, conformal transformations, pressure distributions, circulation, numerical methods and analogies.

ENME 180. Mechanical Engineering Analysis for the Oceanic Environment. (3)
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 181. Mechanical Engineering Systems for Underwater Operations. (3)
Prerequisite, ENME 180 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.

SOLID MECHANICS

ENME 101. Dynamics of Machinery. (2)
One lecture and one laboratory period a week. Prerequisites, ENES 021, ENME 116 concurrently. Dynamic characteristics of machinery with emphasis on systems with single and multiple degrees of freedom.

ENME 153. Elasticity and Plasticity I. (3)
Three lectures a week. Prerequisite, ENME 152. Analysis of plates and shells, thick walled cylinders, columns, torsion of non-circular sections, and rotating disks.

ENME 162. Dynamics II. (3)
Three lectures a week. Prerequisites, ENME 101, ENME 116, 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.

ENGINEERING MATH, EXPERIMENTATION, ETC.

ENME 116. Applied Mathematics in Engineering. (3)
Prerequisite, MATH 21. Mathematical techniques applied to the analyses and solution of engineering problems. Use of differentiation, integration, differential equations, partial differential equations and integral transforms. Application of infinite series, numerical and statistical methods.

ENME 120. Measurements Laboratory. (2)
One lecture and one laboratory period a week. Prerequisites, ENES 30, ENME 101, and ENEE 60, ENME 106 concurrently. Required of juniors in mechanical engineering.

Measurements and measurement systems, applications of selected instruments with emphasis on interpretation of results.

ENME 140. Engineering Analysis and Computer Programming. (3)
Three lectures a week. Prerequisite, ENME 116. Elements of operational calculus, vector analysis, numerical methods and programming for computers. Errors, interpolation, series, integration, iteration and solution of equations.

ENME 154, 155. Engineering Experimentation. (2, 2)
One lecture and one laboratory period a week. Prerequisite, senior standing in mechanical engineering. Theory of experimentation. Selected experiments emphasize planned procedure, analysis and communications of results, analogous systems and leadership.

ENME 166. 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.

For Graduates

DESIGN AND SYSTEM ANALYSIS

ENME 206, 207. Advanced Mechanical Engineering Design. (3, 3)
Prerequisites, ENME 200, 202. 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 212. Control Systems Analysis and Synthesis. (3)
Three lectures per week. Prerequisites, undergraduate automatic control theory background. Linear control systems analysis and synthesis using time and frequency domain techniques, flow graphs, error coefficients, sensitivity, stability, introduction to sample data systems.

ENME 213. Non-Linear and Adaptive Control Systems. (3)
Three lectures per week. Prerequisite, ENEE/ENME 212 or equivalent. Approximate analysis of nonlinear systems using perturbation and linearization techniques, introduction to state space formulation of differential equations, systems with stochastic inputs, stability, introduction to optimum switches systems, adaptive control systems.

ENERGY

ENME 204, 205. Advanced Thermodynamics. (3, 3)
First and second semesters. Three lectures a week. Prerequisites, ENME 104, ENME 106, ENME 151. 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 216, 217. Energy Conversion—Solid State. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 151. Combustion, thermo-electric, thermionic fuel cells, reactors, magnetohydrodynamics, kinetics of reactions, fission and fusion.

ENME 218, 219. Energy Conversion—Plasma State. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 151. Design parameters in chemical, nuclear and direct conversion systems for the production of power, weight, efficiency and radiation.

ENME 229, 230. Jet Propulsion. (3, 3)
First and second semesters. Three lectures a week. Prerequisites, ENME 150, ENME 151. Types of thermal jet units. Fluid reaction and propulsive efficency. Performance of rockets, aerothermodynamics, combustion chemical kinetics, aerodynamics of high speed air flow. Solid and liquid propellant rockets. Design of turbojets and aerojets, ramjets and hydroduct units, including combustion chambers, turbines and compressor.

ENME 231, 232. Advanced Heat Transfer. (3, 3)
First and second semester. Three lectures per week. Prerequisites, ENME 150, ENME 151. Advanced problems covering effects of radiation, conduction, convection, evaporation and condensation. Study of research literature on heat transfer.

FLUID MECHANICS

ENME 208, 209. Design of Turbomachinery. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 151. Characteristics and design of turbines, pumps, compressors and torque convertors; cavitation, stall, and surge.

ENME 210, 211. Advanced Fluid Mechanics. (3, 3)
First and second semesters. Three lectures per week. Prerequisites, ENME 102, MATH 066 or ENME 116. 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 233, 234. Compressible Flow. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 104, MATH 066 or ENME 116, ENME 212. One dimensional subsonic and supersonic flow, compressible flow in ducts and nozzles, two and three dimensional subsonic and supersonic flow, similarity rules, normal and oblique shock waves.

ENME 280, 281. Viscuous Flow. (3, 3)
First and second semesters. 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 280, 281).

ENME 282, 283. Special Topics in Unsteady Hydrodynamics. (3, 3)
First and second semesters. Three lectures per week. Prerequisites, ENME 210, 211. 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 will be placed 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.

SOLID MECHANICS

ENME 200. Intermediate Dynamics. (3)
First semester. Three lectures per week. Prerequisite, ENME 157. 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 201. Advanced Dynamics. (3)
Second semester. Three lectures per week. Prerequisite, ENME 200. 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 202. Continuum Mechanics. (3)
First semester. Three lectures a week. Prerequisite, ENME 152. The algebra and calculus of tensors in Riemannian space are developed with special emphasis on those aspects which are most relevant to mechanics. The geometry of curves and surfaces in E-3 is examined. The concepts are applied to the derivation of the field equations for the non-linear theory of continuous media and to various problems arising in classical dynamics.

ENME 203. Linear Theory of Elasticity. (3)
Second semester. Three lectures per week. Prerequisite, ENME 202. 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 214, 215. Stress Waves in Continuous Media. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 152 and ENME 157. Methods of characteristics applied to transient phenomena in solids and fluids. Elastic and plastic waves under impact. Shock formation and strain rate effects.

ENME 221. Linear Vibrations. (3)
First semester. Three lectures a week. Prerequisite, ENME 157. 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 222. Non-Linear Vibrations. (3)
Second semester. Three lectures per week. Prerequisite, ENME 211. 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 223, 224 Plasticity. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 202. Yield criterion and associated flow rules as related to the behavior of materials in the elastic-inelastic region for both perfectly plastic and strain hardenable materials. Plastic behavior of members in the following areas including, instability, bending, torsion, cylinders, spheres, curved members, limit analysis and metal working theory and applications.

ENME 227. Non-Linear Elasticity. (3)
First semester. Three lectures per week. Prerequisite, ENME 202. This course 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 228. Visco-elasticity. (3)
Second semester. Three lectures per week. Prerequisite, ENME 202. This course treats the behavior of solid materials which posses fluid characteristics. Included within this group are Green-Revlin and hygrosteric materials. The study of objective tensor rates and other invariance requirements leads to the formulation of constitutive equation for variance visco-elastic materials. Steady shear flows, helical flow, visco-elastic torsion and problems arising from the linear visco-elastic theory are considered.

ENME 235, 236. Linear and Non-Linear Elastic Shells. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, ENME 202. Fundamental results from the theory of surfaces. Theories of shells composed of linear and non-linear elastic materials. Discussion of both infinitesimal and finite deformation states. Strain displacement relationships developed to include higher order terms. Derivation of equilibrium equations and their use in static and dynamic stability studies. Constitutive equations for the linear theory. Solutions to special shell problems.

SPECIAL TOPICS AND RESEARCH

ENME 220. Seminar
First or second semester. Credit in accordance with work outlined by mechanical engineering staff. Prerequisite, graduate standing in mechanical engineering.

ENME 238. Advanced Topics in Mechanical Engineering. (2, 3)
First or second semester. Prerequisite, consent of instructor. Advanced topics of current interest in the various areas of mechanical engineering. May be taken for repeated credit.

ENME 399. Thesis Research in Mechanical Engineering.
Credit hours to be arranged. Credit in accordance with work outlined by the staff of mechanical engineering. Prerequisites, graduate standing in mechanical engineering. Research in any field of mechanical engineering such as fluid mechanics, solid mechanics, thermodynamics and heat transfer, energy conversion, design, systems and controls and materials.

ENME 499. Dissertation Research in Mechanical Engineering.
Same description as ENME 399 (Ph.D. level).

METEOROLOGY

Professors: Faller, Landsberg, and Fritz.
Assistant Professors: Gage, Israel,* Rodenhuis, Thompson, and Vernekar.
Visiting Lecturer: Bonner and Gerrity.
Faculty Research Assistant: Kaylor

*Joint appointment with Civil Engineering.

This program 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 metecrology, chemistry, mathematics, physics, astronomy, engineering, or other programs with suitable emphasis in the sciences. Previ-

ous training in meteorology or related sciences will be favorably considered in a student's application for admission to the program. However, such training or experience is not a prerequisite nor may it be considered a substitute for a demonstrated capability in the mathematical and physical sciences, such capability to be determined either from the student's record or by examination. In exceptional circumstances a student may be admitted subject to satisfactory completion of prescribed background courses.

Courses in the major subject may be selected from those courses listed under meteorology. Courses to satisfy the minor requirement may be chosen in chemistry, physics, astronomy, mathematics and engineering, or in other areas of special interest. In all cases the student must satisfy the general requirements of The Graduate School. The student's program will be supervised by a member of the Meteorology teaching faculty. Research problems in meteorology will be supervised by members of the Meteorology Department faculty or by a faculty member of another appropriate department.

Examinations for Candidacy

The Preliminary Examinations (M.S. or Ph.D.)—The preliminary examination is designed to test the student's background in those areas of the mathematical and physical sciences which are required for successful graduate work in meteorology, and together with the student's undergraduate record and experience will serve as guidance to the faculty in the recommendation of a graduate program. This examination will be offered once each semester and is taken by all new students before or during their first year of graduate work. In general this examination may be taken no more than twice.

The Comprehensive Examinations (Ph.D.)—The comprehensive examinations are intended to test the student's mastery of essential subject matter and the ability to apply his knowledge to new situations. Because of the diversity of subject matter in meteorology, due consideration will be given to the area of specialization of the individual student, although the comprehensive nature of the examination will not be compromised. The written examinations will represent questions and problems from the entire faculty in the Department of Meteorology, and those students who satisfy the minimum required grades will be admitted to the oral examinations. The outcome of the examinations will be determined from a combination of the written and oral grades with minimum standards in each category.

Thesis Presentation and Examination (M.S. and Ph.D.)—Each student will submit a thesis and will be required to present his work orally in seminar and to defend his material to the satisfaction of his examining committee.

Requirements for the Master of Science and Doctor of Philosophy Degrees

For the Master of Science degree a minimum of 12 semester hours is required in courses in meteorology approved by the Graduate Committee. The minor program and research credit requirements are those of The Graduate School.

The basic requirement for the Doctor of Philosophy degree is a thesis which embodies an original contribution to knowledge and which demonstrates an ability to present the subject matter in acceptable, scholarly style.

Normally before a candidate is equipped to begin work on the thesis approximately 30 credits of course work in meteorology beyond the bachelor's degree will be needed. Research and language requirements are those of The Graduate School. Languages approved for meteorology are German, French, and Russian.

For Graduates and Advanced Undergraduates

METO 110, 111. Descriptive and Synoptic Meteorology. (3, 3)
Prerequisites, MATH 022, PHYS 021 or equivalent. A survey of atmospheric phenomena, goals of research and techniques of study. This course introduces the new student to the broad range of theoretical and applied studies in meteorology; the interaction of physical and dynamical processes and the various scales of atmospheric phenomena.

METO 112. Physics and Thermodynamics of the Atmosphere. (3)
Prequisites, MATH 022, PHYS 021 or equivalent. Optical phenomena, the radiation balance, introduction to cloud physics, atmospheric electrical phenomena, basic thermodynamic processes and their application to the atmosphere.

METO 120. Physical and Dynamical Oceanography. (3)
Prerequisites, consent of 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.

METO 122. Ocean Waves, Tides and Turbulence. (3)
Prerequisites, ENME 163 or PHYS 117 or equivalent. Introduction to the theory of oceanic wave motions; tides, wind waves, swells, storm surges, seiches, tsunamis, internal waves, turbulence, stirring, mixing and diffusion; probability, statistics and time series.

For Graduates

METO 210. Dynamic Meteorology I. (3)
Prerequisite, MATH 111, METO 111 or equivalent. The equations of fluid motion; circulation and vorticity theorems; basic atmospheric motions; 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 211. Dynamic Meteorology II. (3)
Prerequisites, METO 210 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 212. Atmospheric Turbulence and Diffusion. (3)
Prerequisites, METO 210 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 214. Numerical Weather Prediction. (3)
Prerequisites, METO 211 or equivalent. Numerical techniques for the solution or partial differential equations; application to the equations of atmospheric motion; Eulerian, Lagrangian and spectral methods; numerical models of the general circulation; current applications to research and forecasting.

METO 216. Planetary Fluid Dynamics. (3)
Prerequisites, METO 112, 210 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 230. Statistical Methods in Meteorology. (3)
Prequisites, MATH 132, METO 211 or equivalent. Distribution of scalars and vectors; sampling methods; regression and correlation methods; tests of significance; time series analysis; statistical forecasting methods.

METO 240. Micrometeorology. (3)
Prerequisites, METO 110, 111 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; physical properties of the micro-layer of the atmosphere.

METO 241. Meteorology of Air Pollution. (3)
Prerequisites, METO 110, 111 or equivalent. Review of basic macro- and micro-meteorological considerations; the nature and behavior of atmospheric aerosols; the description and measurement of the properties of air pollution; study of the meso-meteorology of cities and the climatological influences of air pollution.

METO 250, 251. Special Topics in Meteorology. (1-3, 1-3)

METO 254, 255. Seminar in Meteorology. (1, 1)

METO 399. Thesis Research (Arr.) (Master's Level)

METO 499. Dissertation Research (Arr.) (Doctorate Level)

MICROBIOLOGY

Professors: Faber *(Emeritus)*, Doetsch, Hansen, Hetrick, and Pelczar.
Associate Professors: Cook, Roberson, and Young.
Assistant Professors: MacQuillan, Vaituzis, and Weiner.
Lecturers: Stadtman, and Janicki.

The Department of Microbiology offers the degrees of Master of Science and Doctor of Philosophy.

The Department also offers a program of advanced courses emphasizing the biological aspects of microorganisms. All candidates for advanced degrees are required to pursue a rigorous program of fundamental and original research in an area approved by the Department chairman and the staff.

Further information concerning graduate work in microbiology may be obtained from the Department.

For Graduates and Advanced Undergraduates

MICB 101. Pathogenic Microbiology. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, MICB 001. (Vaituzis)

MICB 103. Immunology. (4)
Second semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, MICB 101. (Roberson)

MICB 104. History of Microbiology. (1)
First semester. One lecture period a week. Prerequisite, a major or minor in microbiology. (Doetsch)

MICB 108. Epidemiology and Public Health. (2)
Second semester. Two lecture periods a week. Prerequisite, MICB 001. (Faber)

MICB 111. General Virology. (4)
Second semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, MICB 101 or equivolent. (Hetrick)

MICB 121. Microbial Fermentations. (4)
Second semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, consent of instructor. The application of quantitative techniques for the measurement of enzyme reactions, mutations, fermentation analysis and other physiological processes of microorganisms. (Cook)

MICB 151. Microbial Physiology. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, 8 credits in microbiology and CHEM 031, 033 or equivalent. (MacQuillan)

MICB 160. Systematic Bacteriology. (2)
First semester. Two lecture periods a week. Prerequisite, 8 credits in microbiology. History of bacterial classification; genetic relationships; international codes of nomenclature; bacterial variation as it affects classification. (Hansen)

MICB 181. Microbiological Problems. (3)
First and second semesters; summer session. Prerequisite, 16 credits in microbiology. Registration only upon the consent of the instructor. This course is arranged to provide qualified majors in microbiology and majors in allied fields an opportunity to pursue specific microbiologicol problems under the supervision of a member of the Department. (Staff)

For Graduates

MICB 202. 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. (Young)

MICB 203. Microbial Genetics Laboratory. (2)
First semester. Two three-hour laboratory periods a week. Prerequisite, consent of instructor. A laboratory course designed to acquaint students with the techniques employed in studying gene control of microbial activities. (Young)

MICB 204. Bacterial Metabolism. (2)
Second semester. Two lecture periods a week. Prerequisite, 30 credits in microbiology and allied fields, including CHEM 161 and 163. Bacterial nutrition, enzyme formation, metabolic pathways and the dissimilation of carbon and nitrogen substrates. (MacQuillan)

MICB 206, 208. Special Topics. (1-4, 1-4)
First and second semesters. Prerequisite, 20 credits in microbiology. Presentation and discussion of fundamental problems and special subjects in the field of microbiology. (Staff)

MICB 210. Virology and Tissue Culture. (2)
Second semester. Two lecture periods a week. Prerequisite, MICB 101 or equivalent. Physical, chemical, and biological properties of viruses; viral replication; major virus groups. (Hetrick)

MICB 211. Virology and Tissue Culture Laboratory. (2)
Second semester. Two three-hour laboratory periods a week. Prerequisite, MICB 101 or equivalent. Registration only upon consent of instructor. Laboratory methods in virology with emphasis on cell culture techniques. (Hetrick)

MICB 214. Advanced Bacterial Metabolism. (1)
Second semester. One lecture period a week. Prerequisite, MICB 204 or consent of instructor. A discussion of recent advances in the field of bacterial metabolism with emphasis on metabolic pathways of microorganisms. (Stadtman)

MICB 271. Cytology of Bacteria. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, consent of instructor. A consideration of morphology, differentiation, and cytochemistry of the eubacterial organism. (Doetsch)

MICB 280, 282. Seminar. (1, 1)
First and second semesters. (Staff)

MICB 399. Thesis Research. (Master's Level)
First and second semesters; summer session. Credits according to work done. The investigation is outlined in consultation with, and pursued under, the supervision of a senior staff member of the Department. (Staff)

MICB 499. Dissertation Research. (Doctoral Level)
(Staff)

MUSIC

Professors: Ulrich *(Head),* Berman Bernstein, Gordon, Grentzer, Heim, Helm, Johnson, McCorkle, Moss, and Traver.
Associate Professors: Hudson, Montgomery, Pennington, and Taylor.
Assistant Professors: Gould, Mueller, Schumacher, Serwer, and Wakefield.

Instructor: Steinke.

The Department of Music offers the Master of Music degree in five areas of specialization: music history and literature, theory, composition, conducting and performance; the Doctor of Philosophy degree in two areas: musicology and theory; and the Doctor of Musical Arts degree in two areas: composition and literature-performance. A specialization in music education is available for the degrees of Master of Arts, Master of Education, Doctor of Philosophy, or Doctor of Education.

A statement of Departmental requirements supplementing those of The Graduate School has been formulated for all areas of specialization. Copies may be obtained by applying to the Department.

For Graduates and Advanced Undergraduates

MUSC 112, 113, 152, 153. Applied Music. (2-4 2-4 2-4 2-4)
First and second semesters. Prerequisite, the next lower course on the same instrument. One hour lession and a minimum of six to fifteen practice hours per week. The student will indicate the instrument chosen by adding the proper section number. (Staff)

MUSC 141. Musical Form. (3)
First semester. Prerequisites, MUSC 070, 071. A study of the organizing principles of musical composition, their interactions in musical forms, and their functions in different styles. (Gould)

MUSC 143. 144. Composition. (2, 2)
First and second semesters. Prerequisites, MUSC 070, 071. The principles of musical composition, and their application to the smaller forms. Original writing in nineteenth- and twentieth-century musical idiom's for various media. (Moss)

MUSC 145, 146. Counterpoint. (2, 2)
First and second semesters. Prerequisite, MUSC 070, 071. 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. (Gould)

MUSC 147, 148. Orchestration. (2, 2)
First and second semesters. Prerequisites, MUSC 070, 071. 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. (Steinke)

MUSC 149. Modal Counterpoint. (2)
Second semester. Prerequisite, MUSC 071 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. (Gould)

MUSC 150. Harmonic and Contrapuntal Practices of the Twentieth Century. (2)
Prerequisite, MUSC 071 and 145. A theoretical study of twentieth-century materials: scales, modes, intervals, chord structures, polyharmony, and serial and twelve-tone organization. (Gould)

MUSC 160, 161. Conducting. (2, 2)
First and second semesters. MUSC 160 or the equivalent is prerequisite to MUSC 161. 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. (Hudson, Taylor)

MUSC 163. Contemporary Music. (3)
Prerequisite, MUSC 120, 121, or the equivalent. (Diemer)

MUSC 164. Solo Vocal Literature. (3)
Prerequisite, MUSC 120, 121, or the equivalent. The study of solo vocal literature from the Baroque contata to the art song of the present. The Lied, melodie, vocal chamber music, and the orchestral song are examined. (Pennington)

MUSC 165. Keyboard Music. (3)
Prerequisite, MUSC 120, 121 or the equivalent. The history and literature of harpsichord, organ, and piano music from the Baroque period to the present. Suites, sonatas, and smaller forms are studied with emphasis on the changes of style and idiom. (Bernstein)

MUSC 166. Survey of the Opera. (3)
Second semester. Prerequisite, MUSC 120, 121 or the equivalent. A study of the music, librettos, and composers of the standard operas. (Bernstein)

MUSC 167. Symphonic Music. (3)
First semester. Prerequisite, MUSC 120, 121 or the equivalent. The study of orchestral music from the Baroque period to the present. The concerto, symphony, overture, and other forms are examined. (Ulrich)

MUSC 168. Chamber Music. (3)
Second semester. Prerequisite, MUSC 120, 121 or the equivalent. The history and literature of chamber music from the early Baroque period to the present. Music for trio sonata, string quartet and quintet, and combinations of piano and string instruments are studied. (Ulrich)

MUSC 169. Choral Music. (3)
First semester. Prerequisite, MUSC 120, 121 or the equivalent. The history and literature of choral music from the Renaissance to the present, with discussion of related topics such as Gregorian chant, vocal chamber music, etc. (Helm)

MUSC 175. Canon and Fugue. (3)
Second semester. Prerequisite, MUSC 146 or the equivalent. Composition and analysis of the canon and fugue in the styles of the eighteenth, nineteenth, and twentieth centuries. (Gould)

MUSC 180. Acoustics for Musicians. (3)
Second semester. Prerequisites, MUSC 071 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. (Staff)

MUSC 182. Chamber Music Repertoire. (2)
First and second semesters. Four hours per week. Prerequisite, graduate standing as a major in performance. A systematic study, through performance, of diversified chamber music for the standard media. Repertoire covered will be determined by the personnel available in the class. May be repeated for credit. (Heim and Staff)

MUSC 185. Music Pedagogy. (3)
Conference course, Prerequisite, completion of or current registration in MUSC 152 or more advanced course in applied music. A study of major pedagogical treatises in music, and an evaluation of pedagogical techniques, materials and procedures.
(Gordon, Heim and Pennington)

For Graduates

MUSC 200. Advanced Studies in the History of Music. (3)
Prerequisite, MUSC 120, 121, and consent of instructor. A critical study of one style period (Renaissance, Baroque, etc.) will be undertaken. The course may be repeated for credit, since a different period will be chosen each time it is offered.
(Bernstein, Helm and McCorkle)

MUSC 201. Seminar in Music. (3)
Prerequisite, MUSC 120, 121, 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.
(Helm, McCorkle)

MUSC 202. Pro-Seminar in the History and Literature of Music. (3)
Prerequisite, MUSC 121 and graduate standing. An introduction to graduate study in the history and literature of music. Bibliography and methodology of systematic and historical musicology. (Bernstein)

MUSC 203. Seminar in Musicology. (3)
Prerequisite, MUSC 121 and graduate standing. An intensive course in one of the areas of musicology such as performance practices, history of music theory, history of notation, or ethnomusicology. Since a cycle of subjects will be studied, the course may be repeated for credit. (Bernstein, McCorkle)

MUSC 204. American Music. (3)
Prerequisite, MUSC 121 and graduate standing. A lecture course in the history of American art music from Colonial times to the present. (McCorkle)

MUSC 206. Advanced Modal Counterpoint. (3)
Prerequisite, MUSC 146 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. (Gould)

MUSC 207. The Contemporary Idiom. (3)
Prerequisite, MUSC 146 or the equivalent, and graduate standing. Composition and analysis in the twentieth century styles, with emphasis on techniques of melody, harmony, and counterpoint. (Moss)

MUSC 208. Advanced Orchestration. (3)
Prerequisite, MUSC 148 or the equivalent, and graduate standing. Orchestration projects in the styles of Debussy, Ravel, Stravinsky, Schoenberg, Bartók, and others. May be repeated for credit. (Moss)

MUSC 209. Seminar in Musical Composition. (3)
Prerequisite, MUSC 144 or the equivalent, and graduate standing. An advanced course in musical composition. May be repeated for credit. (Moss)

MUSC 210. Factors in Musical Learning. (3)
Prerequisite, MUSC 121 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. (Taylor)

MUSC 211. Special Studies in Music. (3)
First and second semesters. Prerequisite, MUSC 121 or the equivalent. Conference course in problems in music history, literature, and theory. May be repeated for credit. (Staff)

MUSC 212, 213. Interpretation, Performance, and Analysis of the Standard Repertoire. (2-4 each course)
Prerequisite, consent of the graduate faculty in the Department. A seminar in analysis and interpretation for the graduate performer with advanced instruction at the instrument of the works studied. In MUSC 213 a seminar paper and a full-length recital are required. (Staff)

MUSC 215. Aesthetics of Music. (3)
Prerequisite, MUSC 121 or the equivalent and one course in Aesthetics. A consideration of the principal theories of aesthetics as they relate to music. A study of writings in the field from Pythagoras to the present. (Staff)

MUSC 218. 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. (Ulrich)

MUSC 260. Advanced Conducting. (3)
First semester. Three lectures per week. Prerequisite, MUSC 161 or the equivalent. A concentrated study of the conducting techniques involved in the repertoire of all historical periods. May be repeated for credit. (Traver)

MUSC 270, 271. Advanced Analytical Techniques. (3, 3)
First and second semesters. Three lectures per week. Prerequisite, advanced standing in Music and permission of the instructor. A seminar in which composer and theorist

will develop analytical facility in advanced nineteenth- and twentieth-century music and an inclusive technique of analysis in music from the Renaissance to the present. (Moss)

MUSC 300, 301. Doctoral Seminar in Music Literature. (3, 3)
First and second semesters. Prerequisite, at least twelve hours in music history and literature. An analytical survey of the literature of music: Section 1, keyboard music; Section 2, vocal music; Section 3, string music; Section 4, wind instrument music. Required of all candidates for the D.M.A. degree in Literature-Performance. Normally both semesters must be taken before credit is allowed.
(Heim, Gordon, and Pennington)

MUSC 305. Doctoral Seminar in Music. (3)
Prerequisite, at least twelve graduate hours in music history and a familiarity with musicological methods and bibliography. A study of topics in music history and theory based on original research in the subject areas. Required of all candidates for the Ph.D. degree. May be repeated for credit. (McCorkle)

MUSC 306. Advanced Composition. (3)
First and second semesters. Prerequisite, MUSC 209 or the equivalent, and permission of the instructor. Conference course in composition in the larger forms. May be repeated for credit. (Moss)

MUSC 312, 313, 314. Interpretation, Performance, and Pedagogy. (4, 4, 4)
Prerequisite, consent of the Graduate music faculty. 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. (Staff)

MUSC 399. Thesis Research. (Master's Level)
(Staff)

MUSC 499. Dissertation Research. (Doctoral Level)
(Staff)

PHILOSOPHY

Professor and Chairman: Schlaretzki.
Professor: Pasch.
Visiting Professors: Bedford,[2] Flew,[1] and Walsh.[2]
Associate Professors: Brown[3], Celarier, Perkins, an Svenonius.
Assistant Professors: Johnson, Kress, Lesher, Martin[3] Odell, Roelofs, and Varnedoe.

Lecturers: Curtis, and Sewell.

The Department of Philosophy offers the degrees of Master of Arts and Doctor of Philosophy.

A brochure containing information in detail concerning the graduate program in philosophy, including requirements for admission, may be obtained by writing to the Department.

[1] Fall semester, 1970-71
[2] Spring semester, 1970-71
[3] On leave, 1970-71

For Graduates and Advanced Undergraduates

PHIL 101. Ancient Philosophy. (3)
Prerequisite, six hours in philosophy. (Celarier, Lesher)

PHIL 102. Modern Philosophy. (3)
Prerequisite, six hours in philosophy. (Varnedoe)

PHIL 103. Nineteenth Century Philosophy. (3)
Prerequisite, six hours in philosophy. (Lesher)

PHIL 104. Twentieth Century Philosophy. (3)
Prerequisite, six hours in philosophy. (Brown, Martin, Odell)

PHIL 105. Philosophy in America. (3)
Prerequisite, six hours in philosophy. (Varnedoe)

PHIL 120. Oriental Philosophy. (3)
Prerequisite, one course in philosophy. Not offered on College Park campus.

PHIL 130. The Conflict of Ideals in Western Civilization. (3)
(Staff)

PHIL 141. Philosophy of Language. (3)
Prerequisite, PHIL 041 or 055. (Kress)

PHIL 147. Philosophy of Art. (3)
(Brown)

PHIL 151. Ethical Theory. (3)
Prerequisite, PHIL 045. (Roelofs, Schlaretzki)

PHIL 152. Philosophy of History. (3)
(Martin)

PHIL 154. Political and Social Philosophy. (3)
(Johnson, Schlaretzki)

PHIL 155. Symbolic Logic II. (3)
Prerequisite, PHIL 055 or consent of instructor. Axiomatic development of the propositional calculus and the first-order functional calculus, including the deduction theorem, independence of axioms, consistency, and completeness. (Svenonius)

PHIL 156. Topics in the Philosophy of Science. (3)
Prerequisite, PHIL 056 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. (Staff)

PHIL 157. Theory of Meaning. (3)
Prerequisites, PHIL 041 or 055, and 102. 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. (Kress, Odell)

PHIL 158. Philosophy of Law. (3)
Examination of fundamental concepts related to law, e.g., legal system, law and morality, justice, legal reasoning, responsibility. Prerequisite, one course in philosophy. (Johnson)

PHIL 159. Philosophy of the Social Sciences. (3)
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 judgements in the social sciences; the relation of social science to social policy; problems of methodology. Prerequisite, six hours in social science or consent of instructor. (Staff)

PHIL 160. Philosophy of Mind. (3)
An inquiry into the nature of mind through the analysis of such concepts as consciousness, perception, understanding, imagination, emotion, intention, and action. Prerequisite, PHIL 102. (Perkins)

PHIL 168. Topics in the History of Philosophy. (3)
Prerequisite, PHIL 101 and 102, or consent of instructor. May be repeated for credit when the topics dealt with are different. (Staff)

PHIL 169. Topics in Contemporary Philosophy. (3)
Prerequisite, PHIL 102. 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. (Staff)

PHIL 170. Metaphysics. (3)
First semester. Prerequisite, PHIL 101 and 102. PHIL 055 recommended. A study of some central metaphysical concepts (such as substance, relation, causality, and time) and of the nature of metaphysical thinking. (Pasch)

PHIL 171. Theory of Knowledge. (3)
Second semester. Prerequisite, PHIL 101 and 102. PHIL 055 recommended. The origin, nature, and validity of knowledge will be considered in terms of some philosophic problems about perceiving and thinking, knowledge and belief, thought and language, truth and confirmation. (Brown, Kress, Pasch)

PHIL 175. Topics in Symbolic Logic. (3)
Prerequisite, PHIL 155. May be repeated for credit when the topics dealt with are different. (Svenonius)

PHIL 176. 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. (Svenonius)

PHIL 180. The Philosophy of Plato. (3)
Prerequisite, PHIL 101 and 102. (Celarier, Lesher)

PHIL 181. The Philosophy of Aristotle. (3)
Prerequisite, PHIL 101 and 102. (Celarier, Lesher)

PHIL 182. Medieval Philosophy. (3)
Prerequisite, PHIL 101 or 102. A history of philosophic thought in the West from the close of the classical period to the Renaissance. Based on readings in the Stoics, early Christian writers, Neoplatonists, later Christian writers, and Schoolmen. (Staff)

PHIL 184. The Continental Rationalists. (3)
Prerequisite, PHIL 101 and 102. A critical study of the systems of some of the major 17th and 18th century rationalists, with special reference to Descartes, Spinoza, and Leibniz. (Staff)

PHIL 185. The British Empiricists.(3)
Prerequisite, PHIL 101 and 102. A critical study of selected writings of Locke, Berkeley, and Hume. (Vornedoe)

PHIL 186. The Philosophy of Kant. (3)
Prerequisite, PHIL 101 and 102. (Roelofs)

PHIL 190. Honors Seminar. (3)
Open to honors students in philosophy and, by permission of the instructor, to honors students in other departments. Research in selected topics, with group discussion. May be repeated for credit when the topics dealt with are different. (Staff)

PHIL 191, 192, 193, 194. Topical Investigations. (1-3)
Each semester. (Staff)

For Graduates

PHIL 255. Seminar in the History of Philosophy. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 256. Seminar in the Problems of Philosophy. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 260. Seminar in Ethics. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 261. Seminar in Esthetics. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 270. Seminar in Metaphysics. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 271. Seminar in the Theory of Knowledge. (3)
Prerequisite, consent of instructor. (Staff)

PHIL 292. Selected Problems in Philosophy. (1-3)
Each semester. Prerequisite, consent of instructor. (Staff)

PHIL 399. Thesis Research in Philosophy. (Master's Level)
Each semester. (Staff)

PHIL 499. Dissertation Research in Philosophy. (Doctoral Level)
(Staff)

PHYSICAL EDUCATION, RECREATION AND HEALTH

Professors: Clarke, Eyler, Fraley, Harvey, Humphrey, Husman, and Johnson.
Associate Professors: Churchill, Jones, Kelly, Kenel, Kramer, Leviton, Parker, Steel, Stull, and Tifft.
Assistant Professors: Ingram, Love, Miller, SantaMaria, Tyler, and Vandervelden.

The graduate student majoring in physical education, recreation or health education may pursue the degrees of Master of Arts, Doctor of Education and Doctor of Philosophy. The following undergraduate requirements or their equivalents must be met by every candidate before admission to candidacy

for a graduate degree in physical education: basic sciences (human anatomy and physiology, physiology of exercise), kinesiology, therapeutics, sport skills, methods, human development, measurement, and student teaching. In the event a student has had successful experience in teaching physical education, the prerequisites of sport skills, methods and student teaching may be waived. Undergraduate prerequisites in recreation are as follows: psychology, sociology, principles, administration, basic sciences, recreational activities, and practical experience. Undergraduate prerequisites in health education: biological sciences, bacteriology, human anatomy and physiology, nutrition, chemistry, psychology, measurement, administration, principles, and field work.

Every student majoring in physical education, health education or recreation is required to take PHED, HLTH, RECR 210—Methods and Techniques of Research, PHED, HLTH, RECR 200—Seminar in Physical Education, Recreation, and Health, PHED, HLTH, RECR 399—Thesis Research, and PHED, HLTH, RECR 499—Dissertation Research.

PHYSICAL EDUCATION

*For Graduates and Advanced Undergraduates**

PHED 100. Kinesiology. (4)
First and second semesters; summer session. Three lectures and two laboratory hours a week. Prerequisites, ZOOL 001, 014, and 015, or the equivalent. (Staff)

PHED 120. Physical Education for the Elementary School. (3)
First and second semesters; summer session. (Humphrey)

PHED 155. Physical Fitness of the Individual. (3)
First and second semesters; summer session. (Staff)

PHED 160. Physiology of Exercise. (3)
First and second semesters; summer session. Prerequisite, PHED 100. (Clarke, Stull)

PHED 170. Supervision in Elementary School Physical Education. (3)
First and second semesters; summer session. Prerequisite, PHED 120. (Humphrey)

PHED 180. Measurement in Physical Education. (3)
First and second semesters; summer session. Two lectures and two laboratory periods a week. (Staff)

PHED 185. Motor Learning and Skilled Performance. (3)
First and second semesters; summer session.

PHED 187. Physical Education and Sport in Contemporary Cultures. (3)
First and second semesters; summer session.

PHED 189. Field Laboratory Projects and Workshop. (1-6)
First and second semesters; summer session. (Staff)

PHED 190. Organization and Administration of Physical Education. (3)
First and second semesters; summer session. (Staff)

PHED 191. The Curriculum in Elementary School Physical Education. (3)
First and second semesters; summer session. Prerequisite, PHED 120. (Humphrey)

*A research project must be conducted in each 100 level course taken for graduate credit.

PHED 193. History and Philosophy of Sport and Physical Education. (3)
First and second semesters; summer session. (Eyler, Hult)

PHED 195. Organization and Administration of Elementary School Physical Education. (3)
First and second semesters; summer session. Prerequisite, PHED 120. (Humphrey)

PHED 196. Quantitative Methods. (3)
First and second semesters; summer session. (Staff)

For Graduates

PHED 200. Seminar in Physical Education, Recreation and Health. (1)
First and second semesters; summer session. (Staff)

PHED 201. Philosophy of Physical Education. (3)
First and second semesters; summer session. (Eyler)

PHED 202. Status and Trends in Elementary School Physical Education. (3)
First and second semesters; summer session. (Humphrey)

PHED 203. Supervisory Techniques in Physical Education. (3)
First and second semesters; summer session. (Love)

PHED 204. Physical Education and the Development of the Child. (3)
First and second semesters; summer session. Three lectures a week. (Humphrey)

PHED 205. Analysis of Contemporary Athletics. (3)
First and second semesters; summer session. (Steel)

PHED 206. History of Sport in Western Culture. (3, 3)
First and second semesters; summer session. (Eyler)

PHED 210. Methods and Techniques of Research. (3)
First and second semesters; summer session. (Clarke, Stull)

PHED 215. Principles and Techniques of Evaluation. (3)
First and second semesters; summer session. (Steel)

PHED 230. Research Literature. (3)
First and second semesters; summer session. (Eyler)

PHED 250. Mental and Emotional Aspects of Sports and Recreation. (3)
First and second semesters; summer session. (Husman)

PHED 275. Advanced Analysis of Human Motion. (3)
Prerequisite, PHED 100; first, second and summer sessions. (Kelley)

PHED 280. Scienctific Bases of Exercise. (3)
First and second semesters; summer session. (Clarke)

PHED 285. Seminar in Perceptual Skill Motor Learning and Performance. (3)
May be repeated once. (Schmidt)

PHED 286. Sociology of Sport in Contemporary Perspective. (3)
First and second semesters; summer session. (Ingram)

PHED 287. Advanced Seminars. (1-3)
First and second semesters; summer session. (Staff)

PHED 288. Special Problems in Physical Education. (1-6)
First and second semesters; summer session. (Staff)

PHED 290. Administrative Direction of Physical Education. (3)
First and second semesters; summer session. (Kramek)

PHED 291. Curriculum Construction in Physical Education. (3)
First and second semesters; summer session. (Staff)

PHED 399. Research. (Master's Level)
First and second semesters; summer session. (Staff)

PHED 499. Research. (Doctoral Level)
(Staff)

HEALTH EDUCATION

For Graduates and Advanced Undergraduates

HLTH 150. Health Problems of Children and Youth. (3)
First and second semesters; summer session. (Miller)

HLTH 155. Physical Fitness of the Individual. (3)
First and second semesters; summer session. (Staff)

HLTH 160. Problems in School Health Education in Elementary and Secondary Schools. (2-6)
First and second semesters; summer session. (Staff)

HLTH 170. The Health Program in the Elementary School. (3)
First and second semesters; summer session. Prerequisites, HLTH 002 and 004, or HLTH 040. (Tifft)

HLTH 178. Fundamentals of Sex Education. (3)
First and second semesters; summer session. (Johnson)

HLTH 180. Measurement in Physical Education and Health. (3)
First and second semesters; summer session. (Kelley, Nessler)

HLTH 188. Children's Physical Development Clinic. (1-4)
First and second semesters; summer session. (Johnson)

HLTH 189. Field Laboratory Projects and Workshop. (1-6)
First and second semesters; summer session. (Staff)

HLTH 190. Organization and Administration of School Health Programs. (3)
First and second semesters; summer session. (Johnson)

For Graduates

HLTH 200. Seminar in Physical Education, Recreation and Health. (1)
First and second semesters; summer session. (Staff)

HLTH 210. Methods and Techniques of Research. (3)
First and second semesters; summer session. (Leviton)

HLTH 220. Scientific Foundations of Health Education. (3)
First and second semesters; summer session. (Jones)

HLTH 240. Modern Theories of Health. (3)
First and second semesters; summer session. (Johnson)

HLTH 250. Health Problems in Guidance. (3)
First and second semesters; summer session. (Johnson)

HLTH 260. Public Health Education. (3)
First and second semesters; summer session. (Staff)

HLTH 280. The Scientific Bases of Exercise. (3)
First and second semesters; summer session. (Staff)

HLTH 287. Advanced Seminar. (1-3)
First and second semesters, summer session. (Staff)

HLTH 288. Special Problems in Health Education. (1-6)
First and second semesters; summer session. (Staff)

HLTH 290. Administrative Direction of Health Education. (3)
First and second semesters; summer session. (Jones)

HLTH 291. Curriculum Construction in Health Education. (3)
First and second semesters; summer session. (Miller)

HLTH 399. Thesis Research. (Master's Level)
First and second semesters; summer session. (Staff)

HLTH 499. Dissertation Research. (Doctoral Level)
(Staff)

RECREATION

For Graduates and Advanced Undergraduates

RECR 120. Program Planning. (3)
First and second semesters. Prerequisite, RECR 030. (Parker)

RECR 150. Camp Management. (3)
First and second semesters; summer session. (Harvey)

RECR 180. Leadership Techniques and Practices. (3)
First and second semesters. (Churchill)

RECR S184. Outdoor Education. (6)
Summer only. (Staff)

RECR 185. Planning, Design and Maintenance of Park and Recreation Areas and Facilities. (3)
First and second semesters. (Staff)

RECR 189. Field Laboratory Projects and Workshops. (1-6)
First and second semesters; summer session. (Staff)

RECR 190. Organization and Administration of Recreation. (3)
First and second semesters. (Churchill)

RECR 196. Quantitative Methods. (3)
First and second semesters; summer session. (Staff)

For Graduates

RECR 200. Seminar in Physical Education, Recreation and Health. (1)
First and second semesters; summer session. (Fraley)

RECR 201. Foundations of Recreation. (3)
First and second semesters; summer session. (Staff)

RECR 202. Philosophy of Recreation. (3)
First and second semesters; summer session. (Churchill)

RECR 203. Supervisory Techniques in Recreation. (3
First and second semesters; summer session. (Parker)

RECR 204. Modern Trends in Recreation. (3)
First and second semesters; summer session. (Staff)

RECR 210. Methods and Techniques of Research. (3)
First and second semesters; summer session. (Clarke)

RECR 230. Source Material Survey. (3)
First and second semesters; summer session. (Staff)

RECR 240. Industrial Recreation. (3)
First and second semesters; summer session. (Staff)

RECR 260. Hospital Recreation. (3)
First and second semesters; summer session. (Staff)

RECR 287. Advanced Seminar. (1-3)
First and second semesters; summer session. (Staff)

RECR 288. Special Problems in Recreation. (1-6)
First and second semesters; summer session. (Staff)

RECR 290. Administrative Direction of Recreation. (3)
First and second semesters; summer session. (Churchill)

RECR 399. Thesis Research. (Master's Level)
First and second semesters; summer session. (Staff)

RECR 499. Dissertation Research. (Doctoral Level)
(Staff)

PHYSICS

(For Astronomy, Meteorology and Institute for Molecular Physics [Chemical Physics], see Table of Contents)

Professors: Laster, Westerhout, Banerjee, Brill, Day, Erickson, Ferrell, Glasser,[1] Glover, Greenberg, Griem, Holmgren, Hornyak, Kerr, Krall, Kundu, Levinson, MacDonald, Marion, Misner, Myers, Oneda, Prange, Pugh, Reiser,[2] Snow, Sucher, Trivelpiece, Wall, Weber, and Yodh.

Professors (part-time): Burgers,* Friedman, Hayward, Kolb, McDonald, Musen, Opik, Rado, and Slawsky.

Research Professors: Benedict,** Benesch,** Crane,* Elsasser,* Faller,*** Landsberg,*** Pai,* Tidman,* Vanderslice,** Wilkerson,** and Zwanzig.***

Visiting Professors: (part-time): Fowler, Escobar-V., and Levy.
Associate Professors: Alley, Bardasis, Beaglehole, Beall, Bell, Bhagat, Brush,[6]** Currie, DeSilva, Dorfman,[4] Dragt, Earl, Falk, Fivel, Glick, Griffin, Kacser, Kehoe, H. Kim,[2] Y. S. Kim, Koch, Kunze, T. A. Matthews, Pati, E. Smith, Steinberg, Stephenson, Wentzel, Woo, Zipoy, B. S Zorn, and G. Zorn.
Research Associate Professors: DeRocco,** Ginter,** Guernsey,* Koopman,* Krisher,** Lashinsky,* D. L. Matthews,* Munn,** and Sengers.**
Associate Professors (part-time): Bennett and Dixon.
Assistant Professors: A'Hearn, Anderson, Berg, R. A. Brandt, C. Y. Chang, Connors, Davidson, DiLavore, Gloeckler, Greene, Harrington, Korenman, LaPointe, Layman,[3] Lenchek, Mead, O'Gallagher, Pechacek, Poultney, Redish, Richard, Risk, Roos, Roush, Simonson, Zapolsky and Zuckerman.
Research Assistant Professors: Cable,* and Coplan.*
Research Associates and Post-Doctoral Fellows: Bajaj, Berk, W. D. Brown, R. F. Chang, Creutz, Dewar, Dove, Drew, Ellsworth, Felsch, Fu, Galati, Gowdy, Grodnik, Hinds, C. C. Hsu, Keller, Kujawski, McClellan, Mears, Moritz, Mukhopadhyay, Nutku, Picker, Riddle, Scheerbaum, Sen, Shapiro, S. Smith, Spero, Worrall, Ya'akobi, and Yabuk.
Visiting Lecturers: Armstrong, J. Brandt, T. Clark, and Fichtel.
Part-Time Lecturers: Aitken, Bleil, Drummeter, Eisele, Holt, Karle, Licht, Lide, and Reid.

Entering graduate students normally will be expected to have good 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 he will be expected to make up his deficiencies as soon as possible.

Applicants are strongly advised to take the Graduate Record Examination, including the Advanced Test in Physics, and to have the results sent directly to the Department of Physics and Astronomy. Physics and Astronomy Graduate Assistants receive, beyond tuition costs, a stipend of at least $2,800 for the academic year. Applicants for assistantships are automatically also considered as candidates for fellowships awarded by the Department, such as Center for Theoretical Physics Graduate Fellowship, NSF Traineeships and NDEA Fellowships. Correspondence concerning admission should be directed to the Graduate Entrance Committee, Department of Physics and Astronomy, University of Maryland, College, Md. 20742.

Candidates for the master's degree are required to take four of the following six courses; Theoretical Dynamics (PHYS 200), Statistical Physics (PHYS 201), Methods of Mathematical Physics (PHYS 204), Electrodynamics (PHYS

*Institute for Fluid Dynamics and Applied Mathematics.
**Institute for Molecular Physics.
***Meteorology.
[1] Joint Appointment with Computer Science Center.
[2] Joint Appointment with Electrical Engineering.
[3] Joint Appointment with College of Education.
[4] Joint Appointment with Institute for Fluid Dynamics and Applied Mathematics.
[5] Also Commission on College Physics.
[6] Joint Appointment with History.

205), and Quantum Mechanics (PHYS 212, 213). In addition, they must take Graduate Laboratory (PHYS 209), unless they have a good laboratory background or carry out an experimental thesis. Candidates for the doctor's degree normally will take all of these courses. Advanced Quantum Mechanics (PHYS 254) is required for doctoral students doing dissertations in theoretical physics. It is recommended in the selection of further courses that the student take additional classical courses as well as courses in a variety of fields of modern physics.

Candidates for advanced degrees in physics may have one of their minors in either astronomy, chemistry, chemical physics, mathematics, or engineering in addition to a minor in fields of physics other than their field of major specialization.

There is also a graduate program in chemical physics centered in the Institute of Molecular Physics, with degrees either in Physics or the Chemistry Department.

THESIS (Ph.D.)

Each candidate for the Doctor of Philosophy degree is expected to do an experimental or theoretical thesis which demonstrates his ability to do original research of publishable calibre. He will do his research under the supervision of an experienced faculty member, and will defend his thesis before a committee representing the graduate faculty.

TIME LIMITS

There is a departmental limit on the time taken to get a graduate degree in physics or astronomy. For the Master of Science, this is five calendar years from the date of first enrolling in The Graduate School. For the doctorate, the time limit is seven years from the date of first enrolling in The Graduate School for full-time students and eight years for part-time students.

OFF-CAMPUS COURSES

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 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 where a large number of students are interested in graduate study. 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. For the doctorate in physics, these credits must include at least two credits of Physics 230—Seminar,

and the remainder can be divided among major and minor physics courses and thesis research. 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 staff in the Department.

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 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 backgound he is lacking, and what he must accomplish to receive regular admission. The University of Maryland hopes in this way to offer an opportunity for advanced study in the Department of Physics and Astronomy to all qualified students.

For further information students should write to the Graduate Entrance Committee, Department of Physics and Astronomy.

GENERAL PHYSICS

For Graduates and Advanced Undergraduates

PHYS 100. Advanced Experiments. (2 credits per semester)
Four hours of laboratory per week. Prerequisite, four credits of PHYS 060, 061 or consent of instructor. (LaPointe)

PHYS 102. Optics. (3)
Second semester. Three lectures a week. Prerequisite, PHYS 011 or 021; MATH 021. It is suggested, but not required, that PHYS 060 or PHYS 100 be taken concurrently with this course. (Kunze)

PHYS 103. Applied Optics. (3)
Three lectures a week. Prerequisite, PHYS 102. (Alley)

PHYS 104, 105. Electricity and Magnetism. (3, 3)
First and second semesters. Three lectures a week. Prerequisite, PHYS 011 or 032; MATH 021. (B. S. Zorn)

PHYS 106, 107. Theoretical Mechanics. (3, 3)
First and second semesters. Three lectures a week. Prerequisite, PHYS 051 or consent of instructor. (Staff)

PHYS 109. Electronic Circuits. (4)
Second semester. Three hours of lecture and two of laboratory per week. Prerequisite, PHYS 100 and 105 or concurrent enrollment in PHYS 128. (O'Gallagher)

PHYS 110. Special Laboratory Projects in Physics. (1, 2, or 3)
Two hours laboratory work a week for each credit hour. One to three credits may be taken concurrently, each semester. Prerequisite, PHYS 100 and consent of adviser. (Staff)

PHYS 111. Physics Shop Techniques. (1)
First semester. One three-hour laboratory per week. Prerequisite, PHYS 100 or consent of instructor. (Horn)

PHYS 114, 115. Introduction to Biophysics. (2, 2)
First and second semesters. Two lectures a week. Prerequisite, intermediate physics and MATH 021. (DeRocco)

PHYS 118. Introduction to Modern Physics. (3)
Each semester. Three lectures a week. Prerequisite, general physics and integral calculus, with some knowledge of differential equations and a degree of maturity as evidenced by having taken one or more of the courses PHYS 050 through PHYS 110. (Stephenson)

PHYS 119. Modern Physics. (3)
Each semester. Three lectures a week. Prerequisite, PHYS 118. (Alley)

PHYS 127, 128. Elements of Mathematical Physics. (4, 4)
First and second semesters. Prerequisite, PHYS 018 and MATH 021, or consent of the instructor. Classical dynamics and electrodynamic waves. A careful study of mathematical approaches used in mechanics, electricity and magnetism, and physical optics. (DeSilva, Sucher)

PHYS 129. Introduction to Elementary Particles. (3)
Three lecture hours per week. Prerequisite, PHYS 119 or consent of instructor. Properties of elementary particles, production and detection of particles, relativistic kinematics, invariance principles and conservation laws. (Snow)

PHYS 130, 131. Basic Concepts of Physics. (2, 2)
First and second semesters. Two lectures a week. Prerequisite, junior standing. A primarily descriptive course intended mainly for those students in the liberal arts who have not had any other course in physics. This course does not satisfy the requirements of professional schools nor serve as a prerequisite or substitute for other physics courses. The main emphasis in the course will be on the concepts of physics, their evolution and their relation to other branches of human endeavor. (Brush)

PHYS 140, 141. Atomic and Nuclear Physics Laboratory. (3, 3)
First and second semesters. One lecture and four hours of laboratory a week. Prerequisite, two credits of PHYS 100 and consent of instructor. Classical experiments in atomic physics and more sophisticated experiments in current techniques in nuclear physics. Enrollment is limited to ten students. (Anderson)

PHYS 144, 145. Methods of Theoretical Physics. (4, 4)
First and second semesters. Prerequisite, PHYS 128. A survey of basic ideas in thermodynamics and statistical mechanics. An introduction to electrodynamics, quantum mechanics, and relativity. Primary emphasis will be placed upon the mathematical methods involved in our understanding of these topics. (Kacser)

PHYS 152. Introduction to Thermodynamics and Statistical Mechanics. (3)
Three lectures a week. Prerequisite, MATH 021, PHYS 018 or 051, or consent of the instructor. (Dorfman)

PHYS 153. Modern Physics for Engineers. (3)
Each semester. Three lectures per week. Prerequisites, PHYS 018 or 032 and MATH 022. A survey of atomic and nuclear phenomena and the main trends in modern physics. This course is designed for students who are not physics majors (mathematics, chemistry, engineering). (Roush)

A. GENERAL
Of the courses which follow, 200, 201, 204, 205, 212, 213, 234, 235, 252, 253, 254, 255 and 258 are given every year; all others will be given according to demand.

For Graduates

PHYS 200. Theoretical Dynamics. (3)
Each semester. Three lecture hours per week. Prerequisite, PHYS 127 or equivalent. LaGrangian and Hamiltonian mechanics, two-body central force problem, rigid body motion, small oscillations, continuous systems. (Myers)

PHYS 201. Statistical Physics. (3)
Each semester. Three lecture hours per week. Prerequisite, PHYS 127 or equivalent. Statistical mechanics, thermodynamics, kinetic theory. (Prange, Riddle)

PHYS 202, 203. Advanced Dynamics. (2, 2)
First and second semesters. Two lectures a week. Prerequisite, PHYS 200. A detailed study of advanced classical mechanics. (Myers)

PHYS 204. Methods of Mathematical Physics. (3)
Each semester. Four lecture hours per week. Prerequisite, advanced calculus, PHYS 127 and 128, or equivalent. Ordinary and partial differential equations of physics, boundary value problems, Fourier series, Green's functions, complex variables and contour integration. (Woo, Zipoy)

PHYS 205. Electrodynamics. (4)
Each semester. Three lecture hours per week. Prerequisite, PHYS 204 or equivalent. Classical electromagnetic theory: electro- and magnetostatics, Maxwell equations, waves and radiation, special relativity. (Beall)

PHYS 208. Thermodynamics. (3)
Three lectures per week. Prerequisite, PHYS 201. 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. (Krisher)

PHYS 209. Graduate Laboratory. (3)
Each semester. Six hours of laboratory work per week. Design and performance of advanced experiments in modern and classical physics. (Anderson)

PHYS 212, 213. Introduction to Quantum Mechanics. (4, 3)
First and second semesters. Four lectures per week. 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. (Levinson, Kehoe)

PHYS 222, 223. Boundary-Value Problems of Theoretical Physics. (2, 2)
Prerequisite, PHYS 205. (Falk)

PHYS 228. Symmetry Problems in Physics. (3)
Three lectures per week. Prerequisite, PHYS 213. A study of general methods of classification of physical systems by their symmetries and invariance properties, especially in quantum field theory applications. (Y. S. Kim)

PHYS 240, 241. Theory of Sound and Vibrations. (3, 3)
Three lectures a week. Prerequisite, PHYS 200. A detailed study of acoustics and the theory of vibrations. (Staff)

B. ATOMIC AND MOLECULAR PHYSICS

For Graduates and Advanced Undergraduates

PHYS 126. Kinetic Theory of Gases. (3)
Three lectures a week. Prerequisites, PHYS 127. Dynamics of gas particles, Maxwell-Boltzmann distribution, diffusion, Brownian motion, etc. (Munn)

For Graduates

PHYS 210. Statistical Mechanics. (3)
Three lectures a week. Prerequisites, PHYS 119, and PHYS 201. A study of the determination of microscopic behavior of matter from microscopic models. Micro-canonical, canonical, and grand canonical models. Applications of solid state physics and the study of gases. (Dorfman)

PHYS 214. Theory of Atomic Spectra. (3)
Three lectures a week. Prerequisite, PHYS 213. A study of atomic spectra and structure—one and two electron spectra, fine and hyper-fine structure, line strengths, line widths, etc. (Staff)

PHYS 215. Theory of Molecular Spectra. (3)
Three lectures a week. Prerequisite, PHYS 214. The structure and properties of molecules as revealed by rotational, vibrational, and electronic spectra. (Munn)

PHYS 216, 217. Molecular Physics. (2, 2)
Two lectures per week. Prerequisite, PHYS 213. 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. (Benesch)

C. SOLID STATE PHYSICS

For Graduates and Advanced Undergraduates

PHYS 122. Properties of Matter. (3)
Each semester. Three lecture hours a week. Prerequisite, PHYS 119 or equivalent. Introduction to solid state physics. Electro-magnetic, thermal and elastic properties of metals, semi-conductors and insulators. (Bhagat)

For Graduates

PHYS 218, 219. X-Rays and Crystal Structure. (3, 3)
Three lectures per week. Prerequisite, PHYS 205. A detailed study of crystal structure of solids and of x-rays. (Staff)

PHYS 220. Application of X-Ray and Electron Diffraction Methods. (2)
Two laboratory periods a week. Prerequisite, concurrent enrollment in PHYS 218. The investigation of crystal structure, using x-rays and electron diffraction. (Staff)

PHYS 242, 243. Theory of Solids. (3, 3)
First and second semesters. Two lectures a week. Prerequisite, PHYS 254. Properties of metals, lattice vibrations and specific heats; Boltzmann, Fermi-Dirac, and Bose-Einstein statistics, free electron gas theories, band theory of metals. (Glick)

PHYS 244. Solid State Physics. (3)
Co-requisite, PHYS 213 or equivalent. 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. (Greene)

D. NUCLEAR PHYSICS

For Graduates and Advanced Undergraduates

PHYS 120. Nuclear Physics. (3)
Each semester. Four lecture hours a week. Prerequisite, PHYS 119. 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. (Wall)

For Graduates

PHYS 234, 235. Theoretical Nuclear Physics. (3, 3)
Three lectures a week. Prerequisites, PHYS 254. Nuclear properties and reactions, nuclear forces, two, three, and four body problems, nuclear spectroscopy, beta decay, and related topics. (Griffin)

PHYS 252, 253. Nuclear Structure Physics. (3, 3)
First and second semesters. Three lecture hours per week. Prerequisite, PHYS 120 or equivalent; co-requisite, PHYS 212-213 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. (Hornyak)

E. ELEMENTARY PARTICLE PHYSICS

PHYS 239. Elementary Particles. (3)
Three lectures a week. Prerequisite 237. Survey of elementary particles and their properties, quantum field theory, meson theory, weak interactions, possible extensions of elementary particle theory. (Pati)

PHYS 254. Advanced Quantum Mechanics. (3)
Each semester. Prerequisite, PHYS 213. Relativistic wave equations, second quantization in many body problems and relativistic wave equations, Feynman-Dyson perturbation theory, applications to many body problems, applications to quantum electrodynamics, elements of renormalization. (Levinson, Ferrell)

PHYS 255. Advanced Quantum Mechanics. (3)
Second semester. Prerequisite, PHYS 254. 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. (Oneda, Greenberg)

PHYS 257. Theoretical Methods in Elementary Particle Physics. (3)
First semester. Co-requisite, PHYS 255. (Sucher)

PHYS 258. Quantum Field Theory. (3)
Second semester. Co-requisite, PHYS 255. 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. (Dragt)

PHYS 260. High Energy Physics. (3)
Three lectures a week. Co-requisite, PHYS 254 or consent of instructor. Nuclear forces are studied by examining interactions at high energies. Meson physics, scattering processes, and detailed analysis of high energy experiments. (Pati)

F. ASTROPHYSICS AND GEOPHYSICS

For additional courses, see the section on Astronomy, below.

For Graduates and Advanced Undergraduates

PHYS 123. Introduction to Atmospheric and Space Physics. (3)
Three lectures a week. Prerequisite, PHYS 127 and PHYS 118 or consent of instructor. Motions of charged particles in magnetic fields, aspects of plasma physics related to cosmic rays and radiation belts, atomic phenomena in the atmosphere, thermodynamics of the atmosphere. (Lenchek)

For Graduates

PHYS 221. Cosmic Ray Physics. (3)
Three lecture hours per week. Pre- or co-requisite, PHYS 200, or consent of the instructor. Interaction of cosmic rays with matter, geomagnetic cutoffs, origin and propagation of cosmic rays, the electron component and its relationship to cosmic radio noise; experimental methods. (Earl)

G. PLASMA PHYSICS AND FLUID DYNAMICS

For Graduates and Advanced Undergraduates

PHYS 116, 117. Introduction to Fluid Dynamics. (3, 3)
Three lectures a week. Prerequisites, PHYS 106 and MATH 021. Kinematics of fluid flow, properties of incompressible fluids, complex variable methods of analysis, wave motions. (Faller)

PHYS 124. Introduction to Plasma Physics. (3)
Three lecture hours per week. Prerequisite, PHYS 127 and PHYS 118, or consent of instructor. Orbit theory, magnetohydrodynamics, plasma heating and stability, waves and transport processes. (DeSilva)

For Graduates

PHYS 206. Kinetic Theory of Plasma. (3)
Three hours of lecture per week. Prerequisite, PHYS 204, 205. Knowledge of complex variable theory is also desirable. A detailed study of plasma physics. (Krall)

PHYS 207. Plasma Physics. (3)
Prerequisite, PHYS 204, 205, orbit theory, transport processes, radiation, waves, stability theory. (Trivelpiece)

H. GENERAL RELATIVITY

PHYS 236. Theory of Relativity. (3)
Three lectures a week. Prerequisite, PHYS 200. A study of Einstein's special theory of relativity and some consequences, and a brief survey of the foundations of general relativity. (Weber, Misner)

I. APPLIED PHYSICS

For Graduates and Advanced Undergraduates

PHYS 186. Particle Accelerators, Physical and Engineering Principles. (3)
Three hours of lecture per week. Prerequisites, PHYS 127, 128, or 104, 105 and 118, or equivalents. Sources of charged particles, methods of acceleration and focusing of electron and ion beams in electromagnetic fields; electrostatic accelerators; basic theory of particle motion and orbit stability in cyclic accelerators; constant-gradient cyclotrons and synchronotrons; betatrons and microtrons; the alternating-gradient and sector-focusing principles; isochronous cyclotrons and alternating-gradient synchrotrons; linear accelerators. This course is also listed as Electrical Engineering 186. (H. G. Kim)

For Graduates

PHYS 290. Charged Particle Dynamics, Electrons and Ion Beams. (3)
Three hours per week. Prerequisites, PHYS 127, 128 or PHYS 104, 105 or consent of instructor. 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 290. (Reiser)

J. RESEARCH, SEMINARS AND SPECIAL TOPICS

For Graduates and Advanced Undergraduates

PHYS 150. Special Problems in Physics.
Research or special study. Credit according to work done. Given each semester. Prerequisite, major in physics and consent of adviser. (Staff)

PHYS 190. Independent Studies Seminar. (Credit according to work done)
First and second semesters. Enrollment is limited to students admitted to the Undergraduate Honors Program in physics. (Staff)

For Graduates

PHYS 230. Seminar.
Seminars on various topics in advanced physics are held each semester, with the contents varied each year. One credit for each seminar each semester. (Staff)

PHYS 231. Applied Physics Seminar.
One credit for each semester. (Staff)

PHYS 238. Quantum Theory—Selected Topics. (3)
Three lectures a week. Prerequisite, PHYS 213. (Staff)

PHYS 245. Special Topics in Applied Physics.
Two credits each semester. Two lectures a week. (Staff)

PHYS 248, 249. Special Topics in Modern Physics.
Credit according to work done. Two lectures a week. Prerequisites, calculus and consent of instructor. (Staff)

PHYS 250. Special Problems in Advanced Physics.
Credit according to work done. Projects or special study in advanced physics.

PHYS 399. Thesis Research. (Master's Level)
Credit according to work done, each semester. Prerequisite: an approved application for admission to candidacy or special permission of the Department. (Staff)

PHYS 499. Dissertation Research. (Doctoral Level)
(Staff)

K. SPECIAL PHYSICS COURSES FOR HIGH SCHOOL SCIENCE TEACHERS

The courses in this section were especially designed for high school teachers and are not applicable to B.S., M.S., or Ph.D. degrees in physics without special permission of the Department. However, these courses can be included as part of a physics minor or as electives. No prerequisites are required.

PHYS 118A. Atoms, Nuclei, and Stars. (3)
Three lectures per week. An introduction to basic ideas of the constitution and properties of atomic and subatomic systems and of the overall structure of the universe. (Hornyak)

PHYS 112A. Properties of Materials. (3)
Three lectures per week. An introduction to the study of solid state physics and the properties of fluids. (Bardasis)

PHYS 160A. Physics Problems. (1, 2, 3)
Lectures and discussion sessions arranged. (Laster)

PHYS 170A. Applied Physics. (3)
Three lectures per week. (Hornyak)

PHYS 199. National Science Foundation Summer Institute for Teachers of Science and Mathematics Seminar. (1)
Arranged during summer school. Enrollment limited to participants in the N.S.F. Summer Institute. (DeSilva, Staff)

POULTRY SCIENCE

Professors: Shaffner and Godfrey.
Research Professor: Shorb.
Associate Professors: Bigbee and Creek.
Assistant Professors: Heath, Pollard, and Thomas.

Course work and research leading to the Master of Science and the Doctor of Philosophy degrees are offered. The student may pursue work with the major emphasis either in nutrition, physiology, physiological genetics, or the technology of eggs and poultry.

Department requirements, supplementary to 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.

For Graduates and Advanced Undergraduates

FDSC 160. Technology of Market Eggs and Poultry. (3)
(See FDSC curriculum for description.) (Heath)

AGEC 115. Marketing Animals and Animal Products. (3)
Second semester. Three lectures per week. (See Agricultural Economics AGEC 115.) (Smith)

Poultry Hygiene, see Animal Science, 170. (3) (Newman)

Avian Anatomy, see Animal Science, 171. (3) (Newman)

ANSC 109. Fundamentals of Nutrition. (3)
Second semester. Three lectures per week. Prerequisite, CHEM 031. This course will be for both graduate and undergraduate credit with additional assignments given to the graduate students. (Thomas)

ANSC 162. Avian Physiology. (2)
First semester. One lecture and one laboratory period per week. Prerequisite, ANSC 141 or equivalent. The physiology of the bird is discussed (excluding reproduction). Special emphasis is given to physiological differences between birds and other vertebrates. (Pollard)

ANSC S163. Poultry Breeding and Feeding. (1)
Summer session only. This course is designed primarily for teachers of vocational agriculture and extension service workers. The first half will be devoted to problems concerning breeding and the development of breeding stock. The second half will be devoted to nutrition. (Thomas)

ANSC S164. Poultry Products and Marketing. (1)
Summer session only. This course is designed primarily for teachers of vocational agriculture and county agents. (Heath)

ANSC 165. Physiology of Hatchability. (1)
Second semester. One, three-hour laboratory period per week. Prerequisite, ANSC 141 or equivalent. (Shaffner)

For Graduates

ANSC 221. Energy and Protein Nutrition. (3)
See An. Sci. for description. (Leffel, Thomas)

ANSC 240. Advanced Ruminant Nutrition. (2)
See Dairy Sci. for description. (Vandersall)

ANSC 261. Physiology of Reproduction. (3)
First semester. Two lectures and one laboratory period a week. Prerequisite, ANSC 141 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. (Shaffner)

ANSC 262. 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. (Staff)

ANSC S263. Poultry Nutrition Laboratory. (2)
One lecture and one laboratory period a week. To acquaint graduate students with common basic nutrition research techniques useful in conducting experiments with poultry. Actual feeding trials with chicks as well as bacteriological and chemical assays will be performed. (Creek)

ANSC 264. Vitamins. (2)
First semester. One lecture and one laboratory per week. Prerequisites, ANSC 109, CHEM 031, 033, and 161. Advance study of the fundamental role of vitamins in nutrition including chemical properties, absorption, metabolism, storage, excretion and deficiency syndromes. A critical study of the biochemical basis of vitamin function, interrelationships of vitamins with other substances and of certain special laboratory techniques. (Thomas)

ANSC 265. Mineral Metabolism. (2)
Second semester. Two lectures per week. Prerequisites, CHEM 161 and 163. 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. (Staff)

ANSC 266. 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. (Pollard)

ANSC 280. Seminar in Population Genetics of Domestic Animals. (3)
Second semester. Prerequisites, ZOOL 6, AGRI 101, or their equivalent. 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. (Godfrey)

ANSC 301. Special Problems in Animal Science. (1-2 cr. 4-cr. max.)
First and second semesters. Prerequisite, approval of staff. Work assigned in proportion to amount of credit. Problems will be assigned which relate specifically to the character of work the student is pursuing. (Staff)

ANSC 302. 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. (Staff)

ANSC 399. Thesis Research. (Master's Level)
First and second semesters. Work assigned in proportion to amount of credit. Students will be required to pursue original research in some phase of animal science, carrying same to completion and report the results in the form of a thesis. (Staff)

ANSC 499. Dissertation Research. (Doctoral Level)
(Staff)

PSYCHOLOGY

Professors: Anderson, Bartlett, Gollub, Hodos, Horton, Magoon,* Martin, Taylor, Tyler, and Waldrop.

Associate Professors: Fretz, Goldstein, Locke,***, McIntire, McKenzie,** Mills,** Pumroy,* Scholnick, Steinman, Teitelbaum, Turnage, and Ward.

Assistant Professors: Carroll, Claiborn, Dachler, Dies, Evans, Freeman,** Hegge, Higgs, Holmgren, Johnson, Larkin, Karl,** Osterhouse, Pavey,** Smith, Specter, and Sternheim.

DEGREE REQUIREMENTS

For the master's degree a minimum of 30 hours is required. The major is identified as *general psychology* and consists of two semester courses in Quantitative Methods (six hours) and one course in each of four content areas (12 hours) designated as core areas by the faculty. In addition, the student is required to complete master's thesis research (six hours) and electives (six hours) which are usually chosen from the area of specialization desired for the doctorate.

The student is expected to complete the above requirements within two years. After completion of these requirements, each student is evaluated by a faculty committee of the Department for admission to the doctoral program. The criteria for admission to the doctoral program include academic performance and demonstration of research competence.

After admission to the doctoral program the student must successfully complete comprehensive examinations in his area of specialization. These comprehensive examinations are specially tailored to the interests of each student and are normally given in the third year, after the student has completed most of his coursework. Continuing involvement in research activity is expected of all students, culminating in the research required for the doctoral dissertation.

For Graduates and Advanced Undergraduates

Graduate credit will be assigned only for students certified by the Department of Psychology as qualified for graduate standing.

PSYC 105. Personality. (3)
Prerequisite, PSYC 090 or equivalent. Major personality theories, their postulates and evidence; assessment and research methodology in personality; major areas of personality research, their methodologies, findings, implications, and relationships to the field of psychology.

PSYC 110. Educational Psychology. (3)
Second semester. Prerequisite, PSYC 001. Researches on fundamental psychological problems encountered in education. (Staff)

PSYC 122. Advanced Social Psychology. (3)
Second semester. Prerequisites, PSYC 021, and PSYC 090 or consent of instructor. (Higgs, Taylor, Ward)

*Joint appointment with Education
**Affiliate appointment with Counseling Center
***Joint appointment with Business Administration

PSYC 123. Language and Social Communication. (3)
Second semester. Prerequisite, PSYC 021, senior standing and consent of instructor. (Higgs, Ward)

PSYC 125. Advanced Topics in Child Psychology. (3)
Prerequisite, PSYC 090 or equivalent. The growth and transformation of basic psychological processes from birth to maturity. Emphasis is on research data and methodological issues, especially as they relate to other aspects of psychology.

PSYC 131. Abnormal Psychology. (3)
First and second semesters. Prerequisites, two courses in psychology including PSYC 005. (Staff)

PSYC 135. Personnel and Industrial Psychology. (3)
Prerequisite, PSYC 090 or equivalent. An intensive study of the main areas of industrial psychology with emphasis on primary source material. This course emphasizes research methodology and the relationship of research findings to general theoretical issues.

PSYC 136. Applied Experimental Psychology. (3)
Second semester. Prerequisite, PSYC 001. A study of basic human factors involved in the design and operation of machinery and equipment. Organized for students in engineering, industrial psychology, and the biological sciences. (Anderson, Goldstein)

PSYC 145. Experimental Psychology: Sensory Processes. (4)
First and second semesters. Two lectures and two two-hour laboratory periods per week. Prerequisite, PSYC 090. Primarily for students who major or minor in psychology. A systematic survey of the laboratory methods and techniques applied to sensory and perceptual processes. (Steinman, Sternheim)

PSYC 146. Experimental Psychology: Learning, Motivation and Problem Solving. (4)
First and second semesters. Two lectures and two two-hour laboratory periods per week. Prerequisite, PSYC 090. Primarily for students who major or minor in psychology. The experimental analysis of learning and motivational processes. (Gollub, Hegge, McIntire)

PSYC 147. Experimental Psychology: Social Behavior. (4)
First and second semesters. Two lectures and one two-hour laboratory period per week. Prerequisites, PSYC 021 and PSYC 090 or equivalent. A laboratory course dealing with methods of studying behavior in the social context. Topics will include social perception and motivation, small groups, communication and persuasion. Consideration will be given to the techniques involved in laboratory experimentation, field studies, attitude scale construction, and opinion surveys. (Higgs, Taylor, Ward)

PSYC 148. Pyschology of Learning. (3)
First semester. Prerequisite, PSYC 145 and permission or PSYC 146. Review and analysis of the major phenomena and theories of human and animal learning, including an introduction to the fields of problem solving, thinking and reasoning behavior. (Horton, Martin, Turnage)

PSYC 150. Tests and Measurements. (3)
Prerequisite, PSYC 090. Critical survey of measuring devices used in counseling, educational and industrial practice with an emphasis on the theory, development and standardization. Laboratory work will incorporate training in methodology of test development together with appropriate practice in the use of selected tests. (Waldrop, Fretz, Johnson)

PSYC 151. Psychology of Individual Differences. (3)
Prerequisite, PSYC 150. Problems, theories, and researches related to psychological differences among individuals and groups. (Waldrop, Johnson)

PSYC 152. Mathematical Psychology. (3)
Prerequisite, PSYC 090 or equivalent, and consent of instructor. A survey of mathematical formulations in psychology, including measurement and scaling models, statistical and psychometric models, and elementory mathematical representations of psychological processes in learning, choice, psychophysics, and social behavior.

PSYC 180. Physiological Psychology. (3)
First semester. Prerequisite, PSYC 145 or 146. An introduction to research on the physiological basis of human behavior, including consideration of sensory phenomena, motor coordination, emotion, drives, and the neurological basis of learning.
(Hodos, Teitelbaum)

PSYC 181. Animal Behavior. (3)
Second semester. Prerequisite, consent of instructor. A study of animal behavior, including considerations of social interactions, learning, sensory processes, motivation, and experimental methods, with a major emphasis on mammals. (McIntire, Hodos)

PSYC 182. Experimental Psychology: Sensory Processes II. (4)
Two lectures and four hours of laboratory exercise and research per week. Prerequisite, PSYC 145 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 183. Advanced Social Psychology. (3)
Prerequisite, PSYC 147. A systematic review of researches and points of view in regard to major problems in the field of social psychology.

PSYC 191. Senior Seminar. (3)
First semester. Prerequisites, senior standing and consent of the instructor. The historical and theoretical roots of the science of psychology. Analysis of current psychological theories and their related research. (Staff)

PSYC 194. Independent Study in Psychology. (1-3)
Prerequisites, senior standing and written consent of individual faculty supervisor. Integrated reading under direction leading to the preparation of an adequately documented report on a special topic. (Staff)

PSYC 195. Minor Problems in Psychology. (1-3)
Prerequisite, written consent of individual faculty supervisor. An individualized course designed to allow the student to pursue a specialized topic or research project under supervision. (Staff)

For Graduates

(All the following courses require consent of the instructor. Not all of the graduate courses are offered every year. The times specified for each course are given as estimates.)

PSYC 200. Proseminar: Professional Aspects of Psychological Science. (1)
Prerequisite, consent of faculty advisor. Survey of professional problems in psychology, including considerations of contemporary developments, professional ethics, literature resources, formulation of critical research problems, and discussion of the major institutions requiring psychological services. (Staff)

PSYC 201. Sensory and Perceptual Processes. (3)
Alternate years. Prerequisite, PSYC 180 and 211. The contemporary experimental and theoretical literature on selected problems in sensation and perception.
(Sternheim, Steinman)

PSY 203, 204. Graduate Seminar. (2, 2)
Surveys of contemporary American and foreign research literature in specialized fields of psychology. (Staff)

PSYC 205, 206. Historical Viewpoints and Current Theories in Psychology. (3, 3)
Alternate years. Prerequisite, PSYC 212. A study of the philosophical and scientific background of modern psychology, together with a review of its major systematic viewpoints and issues. (Staff)

PSYC 207. Conditioning and Learning. (3)
Alternate years. Prerequisite, PSYC 212. The literature on the experimental analysis of behavior, with examination of basic experiments and contemporary theories related to them. (Gollub, McIntire, Turnage)

PSYC 208. Verbal Behavior. (3)
Alternate years. Prerequisite, PSYC 123 and 212. Analysis of such topics as verbal learning, psycholinguistics, concept formation, and thinking. (Horton, Turnage)

PSYC 211, 212. Advanced General Psychology. (3, 3)
First and second semesters. Prerequisite, PSYC 145 or 146. A systematic review of the more fundamental investigations upon which modern psychology is based. (Staff)

PSYC 213. 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. (Hegge, Gollub)

PSYC 214. Comparative Psychology. (3)
Prerequisite, PSYC 181 and 212. The experimental literature on the behavior of infra-human organisms. Special topics. (McIntire)

PSYC 215. Advanced Psychophysiology. (3)
Alternate years. An advanced seminar dealing with special selected topics in the area of psychophysiology. (McIntire, Teitelbaum, Hodos)

PSYC 216. 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. (Gollub)

PSYC 220. Psychological Concepts in Mental Health. (3)
Each year. Prerequisite, advanced standing. Concepts in mental health, their theoretical status, experimental evidence, and current use. (Waldrop)

PSYC 221. Seminar in Counseling Psychology. (3)
Selected problems in counseling psychology. (Waldrop, Fretz, Johnson)

PSYC 222. Seminar in Clinical Psychology. (3)
Selected problems in clinical psychology. (Claiborn, Dies, Taylor)

PSYC 223. Seminar in Community Mental Health. (3)
Selected problems in mental health psychology. (Claiborn, Evans, Specter)

PSYC 224. Seminar in Student Personnel. (2)
Prerequisite, permission of instructor. The seminar is designed to acquaint the student with student personnel function at the collegiate level. Attention is devoted to the historical antecedents of student personnel activities, the range of services, their

functions, responsibilities, interrelationships and projected future status. Resource personnel services will participate as needed. (Staff)

PSYC 225, 226. Behavioral Assessment and Measurement. (2, 2)
First and second semesters. Prerequisite, PSYC 150. Logic and methodology of individual assessment and measurement. Survey of the major testing instruments and techniques. (Staff)

PSYC 227, 228 Laboratory in Behavioral Assessment and Measurement. (2, 2)
First and second semesters. Prerequisite, PSYC 150. Administration, scoring interpretation, and use of current appraisal instruments and methods in evaluating a variety of age levels and types of cases, including referred cases from cooperating institutions. (Staff)

PSYC 229. 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. (Staff)

PSYC 230. Seminar in Engineering Psychology. (3)
Alternate years. An advanced seminar covering the analysis of factors, variables, and characteristics of systems which affect human performance and efficiency. (Anderson, Goldstein)

PSYC 231. Training Procedures in Industry. (3)
Prerequisite, PSYC 148 or equivalent. A consideration of psychological principles and methods for improving job performance; skill development laboratory in application of methods and techniques is provided. (Goldstein)

PSYC 232. Personnel Selection and Job Analysis. (3)
Prerequisite, PSYC 161 or equivalent. Psychological measurement as applied to the analysis of job requirements and the development and use of performance criteria and predictors. (Bartlett)

PSYC 233. Social Organization in Industry. (3)
Prerequisite, permission of instructor. Analysis of management organization as social structures, and the application of concepts and methods of social psychology to problems of conflict, cooperation, and leader-group relations. (Dachler, Locke)

PSYC 240. Interview and Questionnaire Techniques. (3)
Psychological concepts and methods in the use of interview, questionnaire, and inventory procedures for the measurement, prediction and alteration of behavior. (Higgs)

PSYC 241. Persuasion and Attitude Change. (3)
Each year. Consideration of the communication process and the various media of mass communication. Factors related to the effectiveness of communication and persuasion are analyzed in the light of experimental evidence, and various strategies and techniques of persuasion are reviewed. (Higgs, Ward)

PSYC 242. Seminar in Social Psychology. (3)
Each year. Analysis and discussion of contemporary systematic positions in social psychology. Review of research methods in the area as well as theories and problems of current importance. (Higgs, Ward)

PSYC 243. Seminar in Small Group Behavior. (3)
Prerequisite, permission of instructor. Review of current approaches to small group behavior, including problem-solving, communication, leadership, and conformity. (Ward, Higgs)

PSYC 252, 253. Advanced Statistics. (3, 3)
First and second semesters. Prerequisite, PSYC 090. Detailed study of the fundamentals of statistical inference, experimental design, and the analysis of regression and correlation concepts and techniques; a basic course for research students in the behavioral sciences. (Staff)

PSYC 254. Factor Analysis. (3)
Prerequisite, PSYC 253. Analysis of major developments in factor theory as applicable to the behavioral sciences, including computational methods and research implications. (Carroll)

PSYC 255. Seminar in Psychometric Theory. (3)
Prerequisite, PSYC 253. Study of psychophysical methods, scaling techniques, and the statistical methods of pattern analysis. (Larkin)

PSYC 256. Mental Test Theory. (3)
Prerequisite, PSYC 253. Development of test theory from psychophysics and measurement theory. Consideration of formal and applied problems involved in developing and utilizing psychological tests and measurements. Special attention is given to problems of reliability, validity, and prediction. (Bartlett, Carroll)

PSYC 257. Seminar in Quantitative Psychology. (3)
Prerequisite, PSYC 253. An advanced seminar covering special topics in statistical and mathematical methods and models in psychology. (Staff)

PSYC 258. Development of Predictors. (3)
Prerequisite, PSYC 153. Review of statistical theory and practices in the design, development and analysis of techniques of prediction in the behavioral sciences, with special attention to the formal and practical problem of criteria for prediction. (Bartlett, Carroll)

PSYC 260. Occupational Development and Choice. (3)
Prerequisite, PSYC 220. Theoretical and research literature on occupational behavior. (Waldrop, Fretz)

PSYC 261, 262. Modification of Human Behavior: Research Methods and Practice. (3, 3)
First and second semesters. The experimental and applied methods available for the induction of behavior change, with emphasis on their relationship to community mental health (first semester); process, outcome, and theory in their application to counseling and psychotherapy (second semester). (Fretz, Johnson)

PSYC 263, 264. Modification of Human Behavior: Laboratory and Practicum. (3, 3)
First and second semesters. Application of methods relevant to behavior change in counseling and psychotherapy. Individual supervision and group consultation. (Staff)

PSYC 265. Advanced Developmental Psychology. (3)
Empirical, experimental and theoretical literature related to developmental processes. (Scholnick)

PSYC 266. Theories of Motivation. (3)
Alternate years. Current treatments of motivational concepts, and analysis of the causal antecedents to behavior. (Staff)

PSYC 267. Theories of Personality. (3)
Scientific requirements for a personality theory. Postulates and relevant research literature for several current personality theories. (Dies, Smith)

PSYC 269. Practicum in Community Mental Health Consultation. (3)
Each year. Prerequisite, advanced standing. Directly supervised fieldwork in mental health consultation. (Claiborn)

PSYC 270. Advanced Abnormal Psychology. (3)
Alternate years. Deviant behaviors and their etiology and taxonomy. (Staff)

PSYC 271. Appraisal of Disabilities. (3)
Human disabilities and their psychological appraisal. (Waldrop)

PSYC 272. Individual Clinical Diagnosis. (3)
Alternate years. Prerequisite, PSYC 226. Case study of emotionally disturbed individuals with a variety of psychological techniques. (Staff)

PSYC 274. Evaluation and Change in Educational Skills. (3)
Methods for the enhancement of reading and other educational skills. (Staff)

PSYC 285, 286. Research Methods in Psychology. (1-3, 1-3)
Each year. Research is conducted on several problems each semester, in a variety of fields of psychology, and under the supervision of various members of the faculty. (Staff)

PSYC 288, 289. Special Research Problems. (1-4, 1-4)
First and second semesters. Supervised research on problems selected from the area of experimental, industrial, social, quantitative, or mental health psychology. (Staff)

PSYC 399. Thesis Research. (Master's Level)
First and second semesters. (Staff)

PSYC 499. Dissertation Research. (Doctoral Level)
(Staff)

SOCIOLOGY AND ANTHROPOLOGY

Professor and Head: Ellis.
Associate Professor and Vice Chairman: Hirzel.
Associate Professor and Director of the Division of Anthropology: Williams.
Professor and Director of the Division of Criminology: Lejins.
Professors: Dager, Ellis, Janes, and Lejins.
Associate Professors: Anderson, Cussler, Henkel, Hirzel, Hoffman, McIntyre, and Williams.
Assistant Professors: Bateman, Braungart, Coates, Cosnow, Federico, Fidelholtz, Franz, Harper, Hunt, Kruegel, Lengermann, Maida, Pease, Rosen, Schwartz, Simons, Teevan, Thomas, Thurman, and Wellford.

The Department of Sociology grants the degrees of Master of Arts and Doctor of Philosophy. Fields of specialization include anthropology, criminology, urban sociology, the family, industrial and occupational sociology, social theory, social psychology, formal and complex organization, stratification, demography, and research methods.

Prerequisites for graduate study leading to an advanced degree with a major in sociology consist of either (1) an undergraduate major (totalling at least 20 semester hours) in sociology or (2) 12 semester hours of sociology (including six semester hours of advanced courses) and 12 additional hours of comparable work in anthropology, economics, political science, or psychology. Graduate Record Exam and letters of recommendation are required for admission.

For Graduates and Advanced Undergraduates

Sociology 001 or its equivalent is prerequisite to all courses.

SOCY 102. Intercultural Sociology. (3) (Franz)

SOCY 111. Sociology of Occupations and Careers. (3) (Coates, Lengermann)

SOCY 112. Rural-Urban Relations. (3) (Henkel)

SOCY 113. The Rural Community. (3) (Staff)

SOCY 114. The City. (3) (Hirzel, Pollitt)

SOCY 115. Industrial Sociology. (3) (Coates, Lengermann)

SOCY 116. Military Sociology. (3) (Coates)

SOCY 118. Community Organization. (3) (Federico)

SOCY 121. Population. (3) (Hirzel, Kruegel)

SOCY 122. Population. (3) (Hirzel, Kruegel)

SOCY 123. Ethnic Minorities. (3) (Lejins, Staff)

SOCY 124. Sociology of Race Relations. (3) (McIntyre, Schwartz)

SOCY 131. Introduction to Social Service. (3) (Federico)

SOCY 136. Sociology of Religion. (3) (Thomas)

SOCY 141. Sociology of Personality. (3) (Cussler, Hunt, Simons)

SOCY 143. Formal and Complex Organizations. (3) (McIntyre, Schwartz)

SOCY 144. Collective Behavior. (3) (Cussler, Simons)

SOCY 145. Social Control. (3) (Braungart)

SOCY 147. Sociology of Law. (3) (Lejins)

SOCY 148. Sociology of the Arts. (3) (Federico)

SOCY 153. Juvenile Delinquency. (3) (Lejins, Maida, Wellford, Staff)

SOCY 154. Crime and Delinquency Prevention. (3)
Prerequisite, Sociology 52 and Sociology 153 or consent of instructor.
(Lejins, Maida, Wellford, Staff)

SOCY 155. Treatment of Criminals and Delinquents in the Community. (3)
(Lejins, Maida, Wellford, Staff)

SOCY 156. Institutional Treatment of Criminals and Delinquents. (3)
Prerequisite, Sociology 52 and Sociology 153 or consent of instructor.
(Lejins, Maida, Wellford, Staff)

SOCY 162. Social Stratification. (3)
(Ellis, Pease)

SOCY 164. The Family and Society. (3)
(Harper)

SOCY 174. Senior Seminar in Social Work. (3)
(Federico)

SOCY 180. Small Group Analysis. (3)
(Franz)

SOCY 186. Sociological Theory. (3)
(Janes, Hunt, Thomas)

SOCY 191. Social Field Training. (1-3)
Prerequisites: for social work field training, SOCY 131; for crime control field training, SOCY 052 and 153. Enrollment restricted to available placements. Supervised field training in public and private social agencies. (Staff)

SOCY 195. Intermediate Statistics for Sociologists. (3)
Prerequisites, SOCY 095 or equivalent and a course in Sociology (other than SOCY 001). Required for all candidates for the master's degree.
(Bateman, Henkel, Simons, Staff)

SOCY 196. Introduction to Research Methods in Sociology. (3)
(Bateman, McIntyre, Staff)

SOCY 199. Independent Study in Sociology. (1-6)
Prerequisites, at least twelve hours of sociology credit to include one or more of the following: SOCY 95; SOCY 186; SOCY 196; and *written* consent of faculty under whose direction the study is to be performed. (Staff)

For Graduates

SOCY 201. Methods of Social Research. (3)
Selection and formulation of research projects; methods and techniques of sociological investigation and analysis. (McIntyre)

SOCY 202. Advanced Research Methods in Sociology. (3)
Prerequisite, SOCY 201 or equivalent. Instruction in more advanced methodology in Sociological research. (Braungart, McIntyre, Simons)

SOCY 204. Practicum in Data Analysis in Field Research. (3)
Prerequisite, SOCY 195 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. (Staff)

SOCY 205. Computer Methods for Sociologists. (3)
Prerequisites, SOCY 186, SOCY 195 (or equivalents), and elementary knowledge of a programming language, (CMSC 12, 20 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. (Henkel)

SOCY 214. Survey in Urban Theory. (3)
Prerequisite, SOCY 014 or 114 or equivalent. Theoretical approaches of Sociology

and other Social Sciences to urbanism, urbanization, and urban phenomena. Selected approaches: Chicago School; metropolitan region; demography; institutions. (Janes, Hirzel, Pollitt, Staff)

SOCY 215. 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. (Pollitt)

SOCY 216. 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. (Coates, Federico, Lengermann)

SOCY 217. Seminar in Field Work in Urban Research. (3)
Prerequisite, SOCY 214. Methods of Research in Sociology applied to the urban and metropolitan community; reviews of needed research; reviews of contemporary research; the design and execution of field studies. (Janes, Hirzel, Pollitt)

SOCY 219. Human Ecology. (3)
Review of research and theory in Human Ecology. Assessment of the Ecological Complex (population, organization, environment, technology). (Henkel)

SOCY 221. Population and Society. (3)
Second semester. Selected problems in the field of population; quantitative and qualitative aspects; American and world problems. (Hirzel, Henkel)

SOCY 230. Comparative Sociology. (3)
Second Semester. Comparison of the social institutions, organizations, patterns of college behavior, and art manifestations of societal values of various countries. (Franz)

SOCY 241. Personality and Social Structure. (3)
First semester. Comparative analysis of the development of human nature, personality, and social traits in select social structures. (Cussler, Hunt, Simons, Staff)

SOCY 246. 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. (Staff)

SOCY 250. Formal Organization. (3)
The study of organizations; 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. (Lengermann, Pease)

SOCY 253. Advanced Criminology. (3)
First semester. Survey of the principal issues in contemporary criminological theory and research. (Lejins, Maida, Wellford, Staff)

SOCY 254. Seminar: Criminology. (3)
Second semester. Selected problems in criminology. (Lejins, Maida, Wellford, Staff)

SOCY 255. Seminar: Juvenile Delinquency. (3)
First semester. Selected problems in the field of juvenile delinquency. (Lejins, Maida, Wellford, Staff)

SOCY 256. Crime and Delinquency as a Community Problem. (3)
Second semester. An intensive study of selected problems in adult crime and juvenile delinquency in Maryland. (Lejins, Maida, Wellford, Staff)

SOCY 257. 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. (Federico)

SOCY 262. Family Studies. (3)
Second semester. Case studies of family situations; statistical studies of family trends, methods of investigation and analysis. (Harper)

SOCY 264. 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.
(Bateman, Simons)

SOCY 266. Research Literature in Social Stratification. (3)
Prerequisite, SOCY 162, 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. The relationships of social stratificaton to ideology and the institutional orders of the society. (Ellis, Pease)

SOCY 271. 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. (Cussler)

SOCY 282. Sociological Methodology. (3)
Second semester. Local and method of sociology in relation to the general theory of scientific method; principal issues and points of view. (Henkel, Hunt)

SOCY 286. Development of European and American Sociological Theory. (3)
Prerequisite, SOCY 186 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. (Hunt, Janes, Thomas, Staff)

SOCY 287. Seminar: Sociological Theory. (3)
Prerequisite, SOCY 186 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.
(Janes)

SOCY 288. 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.
(Staff)

SOCY 291. Special Social Problems. (Credit to be determined)
Individual research on selected problems. (Staff)

SOCY 295. Advanced Statistics for Sociologists. (3)
Prerequisite, SOCY 195 or equivalent. Advanced treatment of inferential statistics; sampling; research design; non-parametric techniques; scaling. Required of all candidates for the Ph.D. degree. (Henkel, Staff)

SOCY 399. Thesis Research. (Master's Level)
(Staff)

SOCY 499. Dissertation Research. (Doctoral Level)
(Staff)

ANTHROPOLOGY

The Division of Anthropology provides beginning and advanced course work in the principal sub-fields: General; Theory; Physical; Cultural; Culture Areas—primarily the Western Hemisphere; Ethnology; and Archeology.

Courses in Anthropology may be regarded as constituting an independent minor in some programs leading to the B.A. degree. They may, at the discretion of the Department of Sociology, be counted toward a major in Sociology.

Anthropology 001 or its equivalent is prerequisite to all other courses in Anthropology.

For Advanced Undergraduates and Graduates

ANTH 101. Cultural Anthropology: Principles and Processes. (3)
Prerequisite, ANTH 001 or 002 or 021. The approach will be topical and theoretical rather than descriptive. (Hulse, Anderson, Hoffman, Williams)

ANTH 102. Cultural Anthropology: World Ethnography. (3)
Prerequisite, ANTH 001, 002, or 021. (Anderson, Clymer, Hoffman)

ANTH 114. Ethnology of Africa. (3)
Prerequisite, ANTH 001 and 002. (Anderson, Cosnow)

ANTH 123. Ethnology of the Southwest. (3)
Prerequisite, ANTH 001 and 002. (Anderson, Williams)

ANTH 124. Ethnology of North American. (3)
Prerequisite, ANTH 001 and 002. (Hoffman)

ANTH 126. Ethnology of Middle America. (3)
Prerequisite, ANTH 001 and 002. (Williams)

ANTH 131. Social Organization of Primitive Peoples. (3)
Prerequisite, ANTH 001 and 002. (Cosnow)

ANTH 134. Religion of Primitive Peoples. (3)
Prerequisite, ANTH 001 and 002. (Anderson)

ANTH 141. Archeology of the Old World. (3)
Prerequisite, ANTH 001 or 041. (Thurman)

ANTH 151. Archeology of the New World. (3)
Prerequisite, ANTH 001 or 041. (Cosnow, Thurman)

ANTH 161. Advanced Physical Anthropology. (3)
Prerequisite, ANTH 001 or 061. (Rosen)

ANTH 171. Introduction Linguistics. (3)
(Fidelholtz)

ANTH 191. Research Problems. (3)
Prerequisite, permission of instructor. Introductory training in anthropological research methods. The student will prepare a paper embodying the results of an appropriate combination of research techniques applied to a selected problem in any field of anthropology. (Staff)

ANTH 198. Anthropological Theory. (3)
Prerequisite, permission of instructor. (Williams)

ANTH 205. Theory of Cultural Anthropology. (3)
History and current trends of cultural anthropological theory, as a basic orientation for graduate studies and research. (Cosnow, Hoffman)

ANTH 281. Processes of Culture Change. (3)
Change in culture due to contact, diffusion, innovation, fusion, integration, and cultural evolution. (Cosnow, Williams)

ANTH 285. Peasant Communities in the Modern World. (3)
Comparative analysis of peasant communities in Latin America, Europe, Middle East, Asia and Africa. (Williams)

ANTH 287. 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. (Staff)

ANTH 287A. Current Developments in Anthropology—Ethno—Musicology. (3)
(Anderson)

ANTH 287B. Current Developments in Anthropology—Ethno—History of North America. (3)
(Hoffman, Thurman)

ANTH 287C. Current Developments in Anthropology—Primatology. (3)
(Rosen)

ANTH 287D. Current Developments in Anthropology—Archaeological Theory. (3)
(Clymer, Thurman)

ANTH 291. Special Problems in Anthropology. (1-6)
Individual research on selected problems in any field of anthropology.

ANTH 399. Thesis Research. (Master's Level)

ANTH 499. Dissertation Research. (Doctoral Level)

SPANISH AND PORTUGUESE LANGUAGES AND LITERATURES

Professors: Goodwyn, Gramberg, Hesse *(Head),* Marra-Lopez, Mendeloff, Parsons, Nemes, and Rand *(Emerita).*
Associate Professor: Rovner.
Assistant Professors: Flores, Natella, and Sosnowski.

THE AREAS AND THE FIELDS

Our discipline is divided into two complementary areas: Spanish literature and Spanish-American literature. *Spanish literature embraces 4 fields:* 1. Medieval Literature, 2. The Golden Age, 3. Enlightenment, Romanticism and Realism, 4. The Contemporary Period. *Spanish-American literature also embraces 4 fields:* 1. Colonial Literature, 2. National Literatures, 3. Modernism, 4. Present-Day Literature.

MASTER OF ARTS

Specific requirements for all Master of Arts candidates: three semester hours in linguistics (SPAN 101 or 201); three semester hours in teaching techniques (SPAN 297); a written comprehensive examination covering the four fields in either of the two areas indicated above; *thesis option:* 18 semester hours of literature, of which at least 15 must be distributed through all four fields of one area, and at least nine must be on the 200 level; thesis in a chosen field, written while taking six semester hours of SPAN 399; Oral examination in defense of the thesis; *nonthesis option:* 24 semester hours in literature, of which at least 21 should be distributed through all four fields of one area, and at least 15 must be on the 200 level.

DOCTOR OF PHILOSOPHY

Programs vary with individuals, but the following are minimum requirements above the Bachelor of Arts degree. Courses already taken in an M.A. program may be offered in partial fulfillment of these minimums. A Ph.D. candidate may work in either of the two areas:

Spanish Literature:		*Spanish-American Literature:*	
Fields:	*Hrs. Required*	*Fields:*	*Hrs. Required*
Medieval	6	Colonial	6
Golden Age	9	National	6
Enlightenment, Romanticism and Realism	9	Modernism	9
Contemporary	6	Present-Day	9
Spanish-American Literature	9	Spanish Literature	9
Methods (SPAN 297)	3	Methods (SPAN 297)	3
Linguistics (201 & 203)	6	Linguistics (201 & 203)	6
Electives	12	Electives	12
Total	60	Total	60

Other requirements include a written comprehensive examination covering the four fields of the chosen major area; *the thesis and supporting courses:* thesis in a chosen field, written while taking 12 semester hours of SPAN 499; oral examination in defense of the thesis; at least half of the courses in the doctoral program, exclusive of research, must be on the 200 level.

For Graduates and Advanced Undergraduates

SPAN 101. Applied Linguistics. (3)
The 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. Analysis, evaluation, and construction of related drills.
(Mendeloff)

SPAN 103, 104. Advanced Grammar and Composition. (3, 3)
Free composition, literary translation, and practical study of syntactical structure.

SPAN 105, 106. Great Themes of the Hispanic Literatures. (3, 3)
The evolution of the pervading themes of the Hispanic literatures, as reflected in representative manifestations across the ages. **(Nemes)**

SPAN 107, 108. Introduction to Medieval Literature. (3, 3)
Spanish literary history from the eleventh through the fifteenth century. Selected readings. (Mendeloff, Staff)

SPAN 109. The *Romancero*. (3)
Comprehensive study of the *romance:* origins and development, metrical structure, themes, influence on other genres, stylistic analysis, criticism. (Mendeloff, Staff)

SPAN 111, 112. Prose and Poetry of the Sixteenth Century. (3, 3)
Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background. (Goodwyn, Hesse)

SPAN 113. Drama of the Sixteenth Century. (3)
From the earliest autos and pasos, the development of Spanish drama anterior to Lope de Vega, including Cervantes. (Rovner)

SPAN 115, 116. Cervantes. (3, 3)
An interpretive study of Don Quixote and the other works of Cervantes in connection with the historical background. (Goodwyn, Rovner)

SPAN 117, 118. Prose and Poetry of the Seventeenth Century. (3, 3)
Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background. (Goodwyn, Hesse)

SPAN 119, 120. Drama of the Seventeenth Century. (3, 3)
First semester devoted to Lope de Vega, dramatic theory, and the Spanish stage. Second semester: Drama after Lope de Vega to Calderon de la Barca and the decline of the Spanish theater. (Rovner)

SPAN 125, 126. Literature of the Eighteenth Century. (3, 3)
Traditionalism, neo-classicism, and pre-Romanticism in prose, poetry and the theater; aesthetics and poetics of the enlightenment. (Rovner)

SPAN 130. The Romantic Movement in Spain. (3)
Poetry, prose and drama of the Romantic period. (Gramberg)

SPAN 131. Nineteenth Century Fiction. (3)
Significant novels of the nineteenth-century realistic movement. (Gramberg)

SPAN 132. Nineteenth Century Poetry and Drama. (3)
Significant poetry and drama of the second half of the nineteenth-century. (Gramberg)

SPAN 133, 134. Modernism and Post-Modernism in Spain and Spanish-America. (3, 3)
A study of the most important works and authors of both movements in Spain and Spanish America. (Nemes)

SPAN 136. Modern Spanish Drama. (3)
Significant plays of the twentieth century. (Marra-Lopez)

SPAN 141, 142. The Generation of 1898 and Its Successors. (3, 3)
Authors and works of all genres of the generation of 1898 and those of the immediately succeeding generation. (Gramberg, Marra-López)

SPAN 143. The Contemporary Spanish Novel. (3)
The novel and the short story from 1940 to the present. (Marra-López)

SPAN 144. Contemporary Spanish Poetry. (3)
Spanish poetry from the Generation of 1927 to the present. (Marra-López)

SPAN 159, 160. Spanish American Fiction. (3, 3)
Representative novels and/or short stories from the Wars of Independence to the present. (Nemes, Staff)

SPAN 162. Spanish-American Poetry. (3)
Main trends, authors and work from the Conquest to Ruben Dario. (Nemes)

SPAN 163, 164. Spanish-American Essay. (3, 3)
A study of the sociopolitical contents and aesthetic qualities of representative works from the Colonial to the Contemporary period. (Nemes)

SPAN 171, 172. Spanish Civilization. (3, 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 culture with special emphasis on the interrelationship of social and literary history. (Staff)

SPAN 173, 174. Latin-American Civilization. (3, 3)
The cultural heritage of the Latin-American people. Pre-Columbian civilizations. Hispanic and other European influences. (Nemes)

For Graduates

In order to be accepted in The Graduate School for specialization in Spanish, a student must already have a substantial panoramic knowledge of Spanish or Spanish-American literature. Accordingly, the special studies courses and the open seminar are not surveys covering the periods indicated. They are intensive investigations within these periods, in which the class acts as a research team concentrating on a different specific theme each semester.

SPAN 201. The History of the Spanish Language. (3)
(Mendeloff)

SPAN 203. Comparative Romance Linguistics. (3)
(Mendeloff)

SPAN 207, 208. Medieval Spanish Literature: Eleventh through Fifteenth Centuries. (3, 3)
Specific authors, genres, and literary periods studied in depth. (Mendeloff)

SPAN 211, 212. Poetry of the Golden Age. (3, 3)
Analyses and studies in depth of specific works of specific poets in the sixteenth and seventeenth centuries. (Goodwyn)

SPAN 215, 216. Seminar: the Golden Age in Spanish Literature. (3, 3)
Specific authors, genres, literary movements and literary periods of the sixteenth and seventeenth centuries studied in depth. (Hesse)

SPAN 225, 226. Eighteenth Century. (3, 3)
Specific authors, genres, and literary movements studied in depth. (Staff)

SPAN 233, 234. The Nineteenth Century. (3, 3)
Specific authors, genres, and literary movements studied in depth. (Gramberg)

SPAN 237, 238. Hispanic Poetry of the Nineteenth and Twentieth Centuries. (3, 3)
Specific authors, genres and literary movements studied in depth.
(Gramberg, Marra-López)

SPAN 241, 242. The Twentieth Century. (3, 3)
Specific authors, genres and literary movements studied in depth. (Marra-López)

SPAN 245. The Drama of the Twentieth Century. (3)
Specific authors and movements studied in depth. (Marra-López)

SPAN 263, 264. Colonial Spanish-American Literature. (3, 3)
Didactic and narrative prose and epic, dramatic and lyric poetry; principal works and authors. (Nemes)

SPAN 265, 266. National Spanish-American Literature. (3, 3)
Characteristics of the national literatures. Romantic and *costumbrista* literature. *Gauchismo* and *indegenismo*. Principal works and authors. (Nemes)

SPAN 281, 282. Reading Course in Peninsular Spanish Literature. (3, 3) (Staff)

SPAN 283, 284. Reading Course in Spanish-American Literature. (3, 3) (Nemes, Staff)

SPAN 291, 292. Open Seminar. (3, 3) (Staff)

SPAN 297. Teaching Spanish in Institutions of Higher Learning. (3) (Flores)

SPAN 399. Thesis Research. (Master's Level)
Credits determined by work accomplished. Guidance in the preparation of master's thesis. Conferences. (Staff)

SPAN 499. Dissertation Research. (Doctoral Level) (Staff)

SPEECH AND DRAMATIC ART

Professors: Strausbaugh, Aylward, Newby, and Pugliese.
Associate Professors: Baker, Farquhar, Linkow, Meersman, and Niemeyer.
Assistant Professors: Abrams, Bankson, Canetta, Doudna, Green, Kennicott, Kirkley, LeDuc, O'Leary, Provensen, Rebach, Vaughan, Weiss, and Wolvin.
Research Professor: Causey.
Research Associates (Part-time): Elkins and Wintercorn.
Lecturer: Spuehler.

The Department offers a course of graduate study in the fields of dramatics, speech, communication, radio-television, or in speech and hearing science leading to the Master of Arts degree. The Department also offers work leading to the degree of Doctor of Philosophy in speech and hearing science.

Department requirements, supplementary to The Graduate School requirements, have been formulated in each of the fields for the guidance of students. Copies may be obtained from the Department.

SPEECH COMMUNICATION

For Advanced Undergraduates and Graduates

SPCH 107. Advanced Oral Interpretation. (3)
Prerequisite, SPCH 013. (Provensen)

SPCH 110. Advanced Group Discussion. (3)
Prerequisite, SPCH 010. (Linkow)

SPCH 111. Seminar. (3)
Prerequisites, senior standing and consent of instructor. Present-day speech research. (Aylward)

SPCH 124, 125. American Public Address. (3, 3)
Prerequisite, SPCH 001 or 007. The first semester covers the period from colonial times to the Civil War period. The second semester covers from the Civil War period through the contemporary period. (Kennicott)

SPCH 133. Communication Processes in Conferences. (3)
Prerequisite, one course in public speaking. Limited to students at the off-campus centers. (Linkow)

SPCH 161. Ancient Rhetoric. (3)
Prerequisite, SPCH 002 or consent of instructor. (Wolvin)

SPCH 162. Modern Rhetoric. (3)
Prerequisite, SPCH 002 or consent of instructor. A study of development of modern rhetorical theories in Europe and America with consideration of application of theories to public address. (Wolvin)

SPCH 163. Materials and Programs for the Development of Listening. (3) (Wolvin)

SPCH 164. Persuasion in Speech. (3)
Prerequisite, SPCH 002 or 011. (Kennicott)

SPCH 180. Honors Seminar. (3)
For Honors students only. Readings, symposiums, visiting lecturers, discussions. (Staff)

For Graduates

SPCH 260. Speech and Drama Programs in Higher Education. (3)
A study of current theories and practices in speech education. (Wolvin)

SPCH 261. Introduction to Graduate Study in Speech. (3) (Rebach)

SPCH 262. Special Problems in General Speech. (3) (Kennicott)

SPCH 263. Rhetorical Theories of Style. (3)
Second semester. Prerequisite, SPCH 124, 125, or 161. Examination of selected theories of style drawn from the fields of rhetoric and literature, and analysis of model speeches. (Kennicott)

SPCH 264. 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. (Rebach)

SPCH 290. 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. (Staff)

SPCH 399. Thesis Research. (Master's Level) (Staff)

SPCH 499. Dissertation Research. (Doctoral Level) (Staff)

DRAMATIC ART

For Advanced Undergraduates and Graduates

DART 113. Play Production. (3)
Prerequisite, DART 016 or consent of instructor. (Rosenthal)

DART 114. The Film as an Art Form. (3)
(Niemeyer)

DART 127. Children's Dramatics. (3)
Principles and methods necessary for staging children's productions on the elementary school level. Major emphasis on creative dramatics; the application of creative dramatics in the 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. (McKerrow)

DART 129, 130. Play Directing. (3, 3)
Prerequisite, DART 008 or consent of instructor. (Meersman, O'Leary)

DART 131. History of the Theatre. (3)
First semester. A survey of the dramatic production from early origin to 1800. (Niemyer)

DART 132. History of the Theatre. (3)
Second semester. A survey of dramatic production from 1800 to the present.
(Niemeyer)

DART 139. Theatre Workshop. (3)
Prerequisite, DART 008 or 014. A laboratory course designed to provide the student with practical experience in all phases of theatre production. Consent of instructor.
(Pugliese)

DART 171. Styles and Theories of Acting. (3)
Prerequisite, DART 008 or consent of instructor. (O'Leary)

DART 175. Stage Design. (3)
Prerequisite, DART 014 or consent of instructor. (Vaughan)

DART 176. Principles and Theories of Stage Lighting. (3)
Prerequisite, DART 175. (Vaughan)

DART 177. Costume Design for the Stage. (3)
Prerequisite, DART 014 or consent of instructor. (Slattum)

For Graduates

DART 270. Seminar: Studies in Theatre. (3)
Research projects adapted to individual backgrounds and special work. (Meersman)

DART 271. The Theory of Pre-Modern Dramatic Production. (3)
An historical survey of production styles. (O'Leary)

DART 272. Special Problems in Drama. (3)
The preparation of adaptations and other projects in dramaturgy. (Pugliese)

DART 273. 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. (Pugliese)

DART 275. Theory of Visual Design for the Performing Arts. (3)
Prerequisite, DART 175, or consent of instructor. An historical and theoretical study of design practices in the performing arts. (Vaughan)

RADIO AND TELEVISION

For Advanced Undergraduates and Graduates

RATV 102. Radio Production. (3)
Prerequisites, RATV 022 and consent of instructor. (Kirkley)

RATV 117. Radio and Television Continuity Writing. (3)
Prerequisite, RATV 022 or consent of instructor. (du Monceau)

RATV 140. Principles of Television Production. (3)
Prerequisite, RATV 022. A study of the theory, methods, techniques, and problems of television production and direction. Units of study covering the television cameras and lenses, lighting theory and practices, scenery and properties, costumes and makeup, graphic arts and special effects are included. Observation of production procedures at nearby television stations. (McCleary)

RATV 146. Television News and Public Affairs. (3)
Prerequisite, RATV 117 or JOUR 101. (McCleary)

RATV 147. Analysis of Broadcasting Processes and Results. (3)
Prerequisite, RATV 022 or consent of instructor. (du Monceau)

RATV 148. Television Direction. (3)
Two-hour lecture, three-hour laboratory. Prerequisites, RATV 022, 140. (Weiss)

RATV 149. Television Workshop. (3)
Two-hour lecture, four-hour laboratory. Prerequisites, RATV 022, 140 and 148, or consent of instructor. (Aylward)

RATV 150. Radio and Television Station Management. (3)
Prerequisite, RATV 022 or consent of instructor. (Kirkley)

RATV 151. Broadcast Programming and Criticism. (3)
An investigation of the professional, historical, social and psychological criticism of American radio and television, together with a critical analysis of contemporary programming trends and conventions. (Kirkley)

RATV 152. International and Comparative Broadcasting Systems. (3)
Prerequisite, RATV 22. 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, cultural and informational dissemination. Monitoring of overseas broadcasts, television programs and discussions with representatives of domestic and foreign international broadcast agencies. (LeDuc)

RATV 155. Film Production. (3)
Prerequisite, consent of instructor. A study of the theoretical and practical aspects of the 16mm film productions. Through reading and practice, students are familiarized with basic cinematography, lighting, editing, pictorial composition and film continuity as a communication arts medium. (Weiss)

For Graduates

RATV 240. Seminar in Broadcasting. (3)
Studies of various aspects of broadcasting. (Aylward)

RATV 241. Special Problems in Broadcasting. (3)
An experimental laboratory course for the development of new ideas in broadcasting. (Kirkley)

RATV 248. Advanced Television Direction. (3)
Prerequisite, RATV 148 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. (Aylward)

SPEECH AND HEARING SCIENCE

For Graduates and Advanced Undergraduates

SPHR 105. Speech-Handicapped School Children. (3)
Prerequisite, SPHR 003 for undergraduates. The occurrence, identification and treatment of speech handicaps in the classrooms. An introduction to speech pathology. (Staff)

SPHR 106. Clinical Practice. (1 to 5 credits, up to 9)
Prerequisite, SPHR 105 and consent of instructor. May be taken for 1-5 credit hours per semester. May be repeated for a total of 9 semester hours credit. Clinical practice in various methods of corrective procedures with various types of speech cases in the University clinic, Veterans hospitals, and public schools. (Boss)

SPHR 108. Educational Phonetics. (3)
This course is designed to relate phonetic science to the classroom. An extensive coverage of broad transcription of General American speech. Students having credit for SPHR 003 or any previous phonetics course are not eligible for this course. (Baker)

SPHR 109. Speech and Language Development of Children. (3)
Admission by consent of instructor. An analysis of normal and abnormal processes of speech and language development in children. (Bankson, Green)

SPHR 112. Phonetics. (3)
Prerequisite, SPHR 003 or consent of instructor. Training in the recognition and production of the sounds of spoken English, with an analysis of their formation. Practice transcription. Mastery of the international phonetic alphabet. (Baker)

SPHR 120. Speech Pathology. (3)
Prerequisite, SPHR 105. A continuation of SPHR 105, with emphasis on the causes and treatment of organic speech disorders. (Boss)

SPHR 126. Semantic Aspects of Speech in Human Relations. (3)
Prerequisite, one course in public speaking. An analysis of speech and language habits from the standpoint of general semantics. (Staff)

SPHR 135. Instrumentation in Speech and Hearing Science. (3)
Prerequisite, SPHR 003. The use of electronic equipment in the measurement of speech and hearing. (Linkow)

SPHR 136. Principles of Speech Therapy. (3)
Prerequisite, SPHR 120. Differential diagnosis of speech and language handicaps and the application of psychological principles of learning, motivation and adjustment in the treatment of speech disorders. (Farquhar)

SPHR 138. Methods and Materials in Speech Correction. (3)
Prerequisite, SPHR 120 or the equivalent. The design and use of methods and materials for diagnosis, measurement, and retraining of the speech-handicapped. (Boss)

SPHR 141. Introduction to Audiometry. (3)
Prerequisite, SPHR 135. Analysis of various methods and procedures in evaluating hearing losses. Required for students whose concentration is in speech and hearing therapy. (Newby, Green)

SPHR 142. Speech Reading and Auditory Training. (3)
Prerequisite, SPHR 135, 141. Methods of training individuals with hearing loss to recognize, interpret and understand spoken language. Required for students whose concentration is in speech and hearing therapy. (Green)

For Graduates

SPHR 201. Special Problems Seminar. (A. through K.) (1, 3)
Prerequisites, 6 hours in speech pathology and consent of instructor. A. Stuttering; B. Cleft Palate; C. Delayed Speech; D. Articulation; E. Cerebral Palsy; F. Voice; G. Special Problems of the Deaf; H. Foreign Dialect; I. Speech Intelligibility; J. Neurophysiology of Hearing; K. Minor Research Problems. (Newby, Staff)

SPHR 202. Techniques of Research in Speech and Hearing. (3)
Prerequisite, 12 hours in speech pathology and audiology. Analysis of research methodology including experimental techniques, statistical analysis and preparation of reports for scientific investigations in speech and hearing science. Required of candidates for Master's degree in speech and hearing therapy. (Spuehler)

SPHR 203. Experimental Phonetics. (3)
Prerequisite, SPHR 112. The application of experimental methods in quantitative analysis of the phonetic elements of speech. (Baker)

SPHR 204. Applied Phonetics. (3)
Prerequisite, SPHR 112 or equivalent. Application of phonetic analysis to communication systems and clinical analysis in speech and hearing. (Baker)

SPHR 205. Advanced Experimental Phonetics. (3)
Prerequisites, SPHR 112, SPHR 203. Application of phonetic analysis in experimental methodology utilizing electronic equipment for making spectrographic analyses of speech phenomena. (Baker)

SPHR 206. Diagnostic Procedures in Speech Pathology. (3)
Prerequisite, 6 hours of speech pathology. A study of diagnostic tools and methods in the analysis of various types of speech disorders. (Farquhar)

SPHR 207. Advanced Principles of Speech and Hearing Therapy. (3)
Prerequisite, SPHR 136 or equivalent, and 6 hours of speech and hearing pathology. A review of learning principles as applied to the training of the speech and hearing handicapped. (Bankson)

SPHR 208. Quantitative Methods in Speech and Hearing Science. (3)
An analysis of current procedures used in quantifying phenomena observed in Speech and Hearing Science. A minimum of 12 hours credit in Speech and Hearing is a prerequisite for this course. (Spuehler)

SPHR 210. Anatomy and Physiology of Speech and Hearing. (3)
Prerequisite, 6 hours in speech pathology and audiology and consent of instructor. A study of anatomy and physiology of the auditory and speech mechanisms. (Doudna, Staff)

SPHR 211. A, B, C, D. Advanced Clinical Practice. (1-12)
Prerequisite, 12 hours in speech pathology and audiology and permission of instructor. Supervised training in the application of clinical methods in the diagnosis and treatment of speech and hearing disorders. (Craven, Doudna)

SPHR 212. Advanced Speech Pathology. (3)
Prerequisites, 6 hours in speech pathology and consent of instructor. Etiology and therapy for organic and functional speech disorders. (Canctta)

SPHR 214. Clinical Audiometry. (3)
Prerequisites, 3 hours in audiology and consent of instructor. Testing of auditory acuity with pure tones and speech. (Doudna)

SPHR 216. Communication Skills for the Hard-of-Hearing. (3)
Prerequisites, 3 hours in audiology and consent of instructor. Speech reading, auditory training, and speech conservation problems in the rehabilitation of the hard-of-hearing. (Doudna)

SPHR 217. Hearing Aid Selection for the Acoustically Handicapped. (3)
Prerequisite, SPHR 214. A laboratory course in modern methods of utilizing electronic hearing aids. (Causey)

SPHR 218. Speech and Hearing in Medical Rehabilitation and Special Education Programs. (3)
Prerequisites, 6 hours in speech pathology and audiology and consent of instructor. Administrative problems involved in the organization and operation of speech and hearing therapy under the different types of programs. (Staff)

SPHR 219. Speech Disorders of the Brain-Injured. (3)
Prerequisites, 6 hours in speech pathology and audiology and consent of instructor. Methods of evaluation and treatment of children and adults who have suffered injury to brain tissue, with subsequent damage to speech and language processes. (Canetta)

SPHR 220. Experimental Audiology. (3)
Prerequisite, 6 hours in audiology. A study of experimental techniques in the investigation of problems in audiology and psychoacoustics. (Causey)

SPHR 221. Communication Theory and Speech and Hearing Problems. (3)
Prerequisite, 6 hours in speech pathology and audiology and consent of instructor. Analysis of current theories of communication as they apply to research and therapy in speech and hearing. (Staff)

SPHR 222. Advanced Bio-Acoustics. (3)
Prerequisite, 6 hours of audiology. Laboratory research methods in the study of hearing mechanisms in animals. (Nabelek)

SPHR 223. Advanced Psycho-Acoustics. (3)
Prerequisite, 6 hours of audiology. Research methodology in the study of human hearing. (Causey)

SPHR 224. The Preparation of Speech and Hearing Scientists in Institutions of Higher Learning. (3)
Prerequisite, 6 hours of audiology and 6 hours of speech pathology. A review of problems involved in the training of personnel who expect to take teaching and research positions at university and college level. (Staff)

SPHR 225. Advanced Semantics. (3)
Prerequisite, 3 hours of semantics. Advanced study of the effects of language in human perception. (Staff)

SPHR 226. Language Problems of the Exceptional Child. (3)
Prerequisite, 6 hours of speech pathology. A survey of special language problems of the mentally retarded, brain-injured, hard-of-hearing and deaf children. (Staff)

SPHR 227. Experimental Design in Speech and Hearing Science. (3)
A seminar devoted to planning and conducting experiments in speech and hearing science. Each student is required to present three pilot studies for discussion. Two hours classwork, two hours laboratory. Permission of instructor required. (Spuehler)

SPHR 229. Clinical and Socio-Economic Aspects of Hearing Loss. (3)
Prerequisite, SPHR 214. Social, economic, legal, medical, hearing conservation, and social welfare aspects of hearing loss for adults. Laboratory work will include identification and monitoring audiometry as well as practical clinical audiology. (Newby)

SPHR 301. Independent Study in Speech and Hearing Science. (1-6)
Student-selected topic of investigation. A proposed topic must be approved prior to registration. In addition to a formal report an oral presentation of the results will be required. May be repeated. Prerequisite, 30 hours of graduate study in speech and hearing science. (Newby, Staff)

VETERINARY SCIENCE

Director and Head: Ladson.
Associate Professors: Dutta, Marquardt, Mohanty, Newman, and Schueler.
Assistant Professors: Albert, and Ingling.
Instructor: Steele.

No advanced degrees are given in the Department of Veterinary Science. Graduate students in other departments are accepted for problems in the Department of Veterinary Science upon approval of the department in which the graduate degree may be given.

ZOOLOGY

Professor and Head: Corliss.
Professors: Anastos, Brown, Burhoe *(Emeritus)*, Grollman, Haley, Jachowski, Otto, and Schleidt.
Research Professors: Cronin,* Flyger,* Koo,* and Sprague.*
Associate Professors: Brinkley, Clark, Contrera, Gainer, Highton, Linder, Morse, Potter, and Ramm.
Research Associate Professors: Eisenberg *(part-time)*, and Mihursky.*
Assistant Professors: Goode, Imberski, Pierce, and Rees.
Research Assistant Professor: Flemmer.*
Lecturer: McIntosh.
Instructors: Jaeger, Kaufman, Moore, Piper, Smith, Smythe, and Stewart.

The Department of Zoology offers programs of study leading to the degrees of Master of Science and Doctor of Philosophy with specialization in the following fields: cellular, organ, comparative and nerve physiology; invertebrate and vertebrate endocrinology; biophysics; cytology; developmental zoology; population, biochemical, radiation and general genetics; animal behavior; ecology, parasitology, protozoology, helminthology, acarology, invertebrate zoology; systematics; ichthyology, herpetology, orinthology and mammalogy. The general academic requirements which must be fulfilled for the master's and doctoral degrees are described earlier in the catalog.

*Staff, Natural Resources Institute, University of Maryland

Admission to graduate study in the Department is restricted to students with an adequate undergraduate preparation in physical as well as biological sciences. This would include upper division courses in zoology and courses in mathematics, 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. Applicants should submit the results of the Graduate Record Examination.

For further information and application forms, write to the Director of Graduate Studies, Department of Zoology, University of Maryland, College Park, Md. 20742.

All zoology courses with laboratory have a laboratory fee of $12.00 per course per semester.

For Graduates and Advanced Undergraduates

ZOOL 102. Vertebrate Physiology. (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, one year of zoology and one semester of organic chemistry. (Gainer)

ZOOL 103. Biophysics. (3)
Three lectures a week. Prerequisites, one year of biology, a year of physics, at least one semester of calculus, or permission of the instructor. An introduction to the ideas and methods used in biophysics to analyze the functional components of cells and tissues as physical-chemical systems. (Goode)

ZOOL 104. Vertebrate Physiology. (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, one year of zoology and one semester of organic chemistry. (Contrera)

ZOOL 105. General Endocrinology. (3)
Three lectures a week. Prerequisite, one year of zoology and one semester of organic chemistry. (Brinkley)

ZOOL 106. Molecular Genetics. (3)
Three lectures a week. Prerequisites, a course in genetics and one year of organic chemistry. The molecular basis of gene structure and function. Regulation of differential gene expression. (Imberski)

ZOOL 108. Animal Histology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in general zoology and a course in vertebrate anatomy, or permission of the instructor. A study of the microscopic anatomy, ultrastructure and histophysiology of tissues and organs of vertebrates. (Haley)

ZOOL 109. Cell Biology. (4)
Two lectures, one one-hour demonstration-discussion period and one three-hour laboratory period a week. Prerequisites, two years of zoology and organic chemistry, or permission of the instructor. (Brown)

ZOOL 110. General Parasitology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, two years of zoology and one year of chemistry, or permission of the instructor. (Jachowski)

ZOOL 118. Invertebrate Zoology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology. (Linder)

ZOOL 120. Vertebrate Embryology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology. (Ramm)

ZOOL 121. Animal Ecology. (3)
Two lectures and one three-hour laboratory period a week. Prerequisite, one year of zoology. (Morse)

*ZOOL 125S. Fishery Biology and Management. (5)
Five 75-minute lectures and four 3-hour laboratories each week for six weeks. Prerequisite, one year of zoology and permission of instructor. Study of fish identification, development, life history stages, food habits, age and growth, spawning, migration and population dynamics. (Koo and Faculty)

ZOOL 127. Ichthyology. (4)
Two lectures and one two-hour and one three-hour laboratory period a week. Prerequisites, ZOOL 001, 002 and 005 or equivalent. (Clark)

ZOOL 128. Zoogeography. (3)
Three lectures a week. Prerequisites, ZOOL 001, 002, and 005 or equivalent. (Potter)

ZOOL 129. Vertebrate Zoology. (4)
Two lectures and two two-hour laboratory periods a week. Prerequisites, two years of zoology or permission of instructor. (Clark)

ZOOL 130. Hydrobiology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of biology or permission of instructor. (Staff)

ZOOL 180. Cell Differentation. (3)
Three lectures per week. Prerequisites, a course in embryology, cell biology, or genetic systems, or permission of the instructor. A discussion of cellular and subcellular differentiation, emphasizing the biochemical and ultrastructural bases of these developmental changes. (Goode)

ZOOL 182. Ethology. (4)
Two lectures and two two-hour laboratory periods a week. Prerequisites, two years of zoology, including a course in comparative anatomy, or permission of instructor. The function, causation, and evolution of behavior. Laboratory analysis of the behavior of several species. (Staff)

ZOOL 190. Evolution. (3)
Three lectures a week. Prerequisite, a course in genetics or permission of instructor. (Highton)

For Graduates

ZOOL 201. Comparative Physiology. (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, 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. (Brinkley)

ZOOL 203. Advanced Embryology. (4)
Two lectures and four hours of laboratory a week. Prerequisites, a course in embryology and a course in physiology. The biochemical basis of development. (Ramm)

*Offered at the Chesapeake Biological Laboratory, Solomons, Maryland—summer only.

ZOOL 204. 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 109 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. (Staff)

ZOOL 205. 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 the instructor. A systematic approach to the structure and physiology of neuro-endocrine systems of invertebrates. (Linder)

ZOOL 206. 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. A course concerned with electrical phenomena occurring in living matter and with the effect of electrical current on cells, with special emphasis on nerves and muscles. (Gainer)

ZOOL 207. Zoology Seminar. (Arranged)
One seminar a week for each credit hour. A. cytology; B. embryology; C. fisheries; D. genetics; E. parasitology; F. physiology; G. systematics; H. behavior; I. recent advances J. endocrinology, and K. ecology. (Staff)

ZOOL 208. Special Problems in Zoology. (Arranged)
A. cytology; B. embryology; C. fisheries; D. genetics; E. parasitology; F. physiology; G. systematics; H. behavior; I. general; J. endocrinology, and K. ecology. (Staff)

ZOOL 210. Systematic Zoology. (4)
Three lectures and one three-hour laboratory period a week. The principles and methods involved in the classification of animals, with emphasis on population dynamics and speciation. Methods of evaluating taxonomic data, principles of zoological nomenclature, field and museum techniques, and the factors influencing the distribution of animals are also stressed. (Highton)

ZOOL 211, 212. Lectures in Zoology. (1-3, 1-3)
One, two or three lectures a week. Advanced lectures by outstanding authorities in their particular field of zoology. As the subject matter is continually changing, a student may register several times, receiving credit for several semesters. (Visiting Lecturers)

ZOOL 215. Sociobiology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in behavior and permission of the instructor. The course will deal with the description and analysis of animal social organizations, the adaptive nature of animal societies, the effects of early experience, and the role of communication in the integration of animal groups. (Eisenberg)

ZOOL 216. Advanced Topics in Cell Biology. (3)
Three lecture-discussion periods a week. Prerequisites, one year of biochemistry, one year of physics, a course in cell biology or physiology, or permission of the instructor. An inquiry into the physico-chemical background and current advances in selected aspects of cell structure and function. (Brown)

ZOOL 220. 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. (Highton)

ZOOL 221. 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. (Staff)

ZOOL 223. Analysis of Animal Structure. (4)
Two lectures and four hours of laboratory a week. Prerequisite, a course in embryology. The experimental basis of developmental mechanics. (Ramm)

ZOOL 234. 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. (Grollman)

ZOOL 235. Comparative Behavior. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, usually a course in behavior and one in physiology, and permission of the instructor. Orientation and migration, communication, coding, brain and behavior, biological rhythms, and hormones and behavior are the main subjects that will be considered. (Schleidt)

ZOOL 236. 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. (Contrera)

ZOOL 237. Comparative Vertebrate Endocrinology. (3)
Three lectures each week. Prerequisite, one semester of biochemistry, physiology and endocrinology. Study of the difference and similarities in the structure and functioning of the endocrine organs of the vertebrate species. (Brinkley)

ZOOL 240. 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 population. Studies of growth and regulation of animal populations are emphasized. (Morse)

ZOOL 245. Biology of Birds. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, a course in vertebrate zoology or permission of instructor. Emphasis will be on ecology, behavior, anatomy, systematics, and reproductive physiology, plus field studies of local birds. (Staff)

ZOOL 250. Experimental Parasitology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, a course in parasitology and permission of the instructor. Experiments will be performed utilizing living parasites in laboratory animals to illustrate various aspects of the host-parasite relationship. (Jachowski)

ZOOL 251. 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. (McIntosh)

ZOOL 252. Protozoology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, one year of zoology and permission of the instructor. A study of the classification, structure and biology of the protozoa. (Otto)

ZOOL 253. Physiology of Symbiosis. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, one year of biochemistry and permission of instructor. A consideration of the biology of symbiotic organisms, especially the physiological concert existing between host and symbiont. (Staff)

ZOOL 260. Quantitative Zoology. (4)
Three lectures and one three-hour laboratory period a week. Prerequisites, MATH 019 or equivalent and permission of the instructor. A consideration of the statistical techniques of principal importance in the analysis of biological data. (Staff)

ZOOL 300. Advanced Topics in Parasitology. (Arranged)
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.
(Anastos, Haley, Jackowski, Otto)

ZOOL 399. Thesis Research. (Master's Level)
Work on thesis only. A. cytology; B. embryology; C. fisheries; D. genetics; E. parasitology; F. physiology; G. systematics; H. behavior; I. invertebrate zoology; J. endocrinology; K. ecology. (Staff)

ZOOL 499. Dissertation Research. (Doctoral Level)
(Staff)

SCHOOL OF DENTISTRY

ANATOMY

Professors: Hahn and Piavis.
Assistant Professor: Sachs.
Lecturer: Lindenberg.

Graduate programs leading to the Master of Science and the Doctor of Philosophy degrees are offered in the Department of Anatomy.

Applications for admission to departmental graduate programs leading to the master's or doctoral degrees must be approved by the Graduate Admissions Committee of the School of Dentistry. Applicants are expected to have sound academic records in undergraduate study and to have achieved satisfactory scores on the Graduate Record Examination. Further information about requirements may be obtained by writing to the chairman of the Graduate Admissions Committee or to the chairman of the department concerned.

For Graduates and Advanced Undergraduates

ANAT 111. Human Gross Anatomy. (8)
First semester. Three lectures and four laboratory periods per week. This course, through lectures, demonstration, and required regional dissections conducted over the entire human body, provides an opportunity for the student to become imbued with principles of body structure and functions, the knowledge of which is derived from a study of its development, its tissues, its organs, and the actions and interactions of its several systems. Frequent student conferences supplement the normal didactic presentations. (Hahn, Piavis, Sachs)

ANAT 112. Human Neuroanatomy. (2)
Second semester. Three lectures and two laboratory periods per week for eight weeks. Prerequisite, ANAT 111. Its equivalent, or permission of the Department Head. The course consists of a study of the human brain and spinal cord through gross dissection and microscopic methods. Correlation is made, whenever possible, with the student's work in histology and physiology of the central nervous system. (Hahn, Piavis, Sachs, Lindenberg)

For Graduates

ANAT 211. Human Gross Anatomy. (8)
Same as ANAT 111 but with additional work on a more advanced level. (Hahn, Piavis, Sachs)

ANAT 212. Human Neuroanatomy. (2)
Same as ANAT 112 but with additional instruction of a more advanced nature. (Hahn, Piavis, Sachs, Lindenberg)

ANAT 214. The Anatomy of the Head and Neck. (3)
One conference and two laboratory periods per week for one semester. This course is designed to provide the student with a detailed study of the basic anatomy of the region and to correlate this knowledge with the various aspects of clinical practice. (Hahn, Piavis, Sachs)

ANAT 399. Thesis Research. (Master's Level)
(Credit by arrangement.) (Staff)

ANAT 499. Dissertation Research. (Doctoral Level)
(Staff)

BIOCHEMISTRY

Associate Professor: Ganis *(Chairman),* and Leonard.
Assistant Professors: Morris, and Courtade.

For Graduates

BIOCHEM 211. Advanced Biochemistry. (6)
Second semester. Four lectures, one laboratory, and one conference period a week. The course includes the chemistry and intermediary metabolism of carbohydrates, lipids, proteins, enzymes, vitamins, and hormones. Physical-chemical principles as applied to biological reactions are also considered. (Staff)

BIOCHEM 399. Thesis Research. (Master's Level)
(Staff)

BIOCHEM 499. Dissertation Research. (Doctoral Level)
(Staff)

HISTOLOGY

Professor: Provenza.
Associate Professor: Barry.
Assistant Professors: Chang and Sisca.
Instructor: Gartner.

HISTOL 111. Mammalian Histology and Embryology. (8)
First semester. The course embraces the thorough study of the cells, tissues and organs of the various systems of the human body. Although certain aspects of the

dental histology phase of the course are given strictly as special entities, many are included in the instruction in general histology, since the two areas are so intimately related when functional and clinical applications are considered. The instruction in embryology is correlated with that in histology. It covers the fundamentals of development of the human body, particular emphasis being given to the head and facial regions, the oral cavity, and the teeth and their adnexa. Specific correlations are also made with the other courses in the dental curriculum. (Staff)

For Graduates

HISTOL 212. Mammalian Histology and Embryology. (6)
First semester. This course is the same as HISTOL 111, except that it does not include the dental phases of HISTOL 111, but does include additional instruction and collateral reading of an advanced nature. (Staff)

HISTOL 213. Mammalian Oral Histology and Embryology. (2)
First semester. Prerequisite, HISTOL 111 or 212, or an equivalent course. This course covers the dental aspects of HISTOL 111, and includes additional instruction in the relations of histologic structure and embryologic development of the teeth, their adnexa, and the head and facial regions of the human body. (Staff)

HISTOL 216. Inheritance and Development Biology. (6)
This course is concerned with the study of the embryogeny and fetal developments of vertebrate animals with special emphasis on mammalian embryology. In addition to tracing the development pattern, lectures are devoted to the discussion of inheritance mechanisms, gametogenesis and fertilization. (Staff)

HISTOL 217. Comparative Animal Histology. (6)
Prerequisite, HISTOL 111, 212-213, or an equivalent course. This course is concerned with a comparative study of the morphology, structure and function of the cells, tissues and organs as found in representative members of the animal kingdom. Special emphasis is placed on techniques and research methods. (Staff)

HISTOL 218. Experimental Embryology. (4)
Second semester of every year. Prerequisite, HISTOL 216, or an equivalent course. This course is concerned with the historical and recent aspects of experimental embryology from both the applied and theoretical standpoint. Each student will be assigned a special problem in addition to the scheduled lectures. (Staff)

HISTOL 219. Radiation Biology. (4)
Second semester of alternate years. The primary aim of this course is to familiarize the student with the techniques of handling radioactive isotopes as applied in biological research. The topics covered in the course are: the physics of radioactivity from the standpoint of the biological researcher; the selection of isotopes for specific investigations; the effects of radioactivity on cells, tissues and systems; the effect of radioactivity on inheritance; the role of environment on the effectiveness of radioactivity; and certain phases of laboratory health physics. The laboratory will be concerned with the use and location as well as recording and interpreting data of isotopes as applied to biological research. Permission of instructor required. (Staff)

HISTOL 220. Physical Methods in Histology. (4)
Second semester of alternate years. The course introduces the graduate student to some of the more frequently employed techniques in cytological and histological research. Exercises are designed for the operation and interpretation of data derived from the use of available research tools. Two one-hour lectures and one four-hour laboratory period per week. Consent of instructor required. (Staff)

HISTOL 221. Special Problems in Histology and Embryology.
(Number of hours and credit by arrangement.) Prerequisite, HISTOL 111 and HISTOL 219 or 220. This course is designed to provide experience in the organization and execution of small research projects in cytology and histology. Consent of department head required. (Staff)

HISTOL 320. Seminar. (1, 1)
(Staff)

HISTOL 399. Thesis Research. (Master's Level)
(Number of hours and credit by arrangement.) (Staff)

HISTOL 499. Dissertation Research. (Doctoral Level)
(Number of hours and credit by arrangement.) (Staff)

MICROBIOLOGY

Professor: Shay.
Associate Professor: Krywolap.
Assistant Professors: Delisle, Halem, Joseph, Nauman, and Schneider.
Lecturers: Jansen and Libonati.

The Department of Microbiology serves the School of Dentistry and offers programs leading to the degrees of Master of Science and Doctor of Philosophy. The graduate program is especially designed to train students for positions in research and teaching, with particular emphasis on research problems related to the dental sciences. The student may specialize in the areas of pathogenic microbiology, fermentation, antibiotics, antiseptics, oral microbiology, immunology, mycology, virology, microbial genetics and cytology.

For Graduates and Advanced Undergraduates

MICB 121. Dental Microbiology and Immunology. (5)
First semester. Consideration is given to pathogenic bacteria, viruses, yeasts and molds. Special attention is given to those organisms which produce lesions of the oral cavity. Immunological principles are studied with emphasis on hypersenitivity resulting from antibiotics, antigens and vaccines. Laboratory teaching includes cultural characteristics, disinfection, sterilization, asepsis, animal inoculation, antibiotics assay and virus techniques. In all phases of the course emphasis is placed on dental applications. (Staff)

MICB 101. Pathogenic Microbiology. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, MICB 001. The role of microorganisms in the diseases of man and animals with emphasis upon the differentiation and culture of microorganisms, type of disease, modes of disease transmission; prophylactic, therapeutic and epidemiological aspects. This course is presented in the University College program. (Joseph, Libonati)

MICB 151. Serology-Immunology. (3)
First semester, alternate years. Three lectures a week. Prerequisite, MICB B101 or equivalent. Study of the theories and principles of immunological reactions to infectious and noninfectious agents. Demonstration of basic serologic phenomena and their use in laboratory diagnosis. This course is presented in the University College program. (Joseph)

MICB 152. Virology. (3)
Second semester, alternate years. Three lectures a week. Prerequisite, MICB B101 or equivalent. Consideration of the characteristics and properties of viruses and rickettsiae, with emphasis on concepts of pathogenicity, immunity, epidemiology and identification. Discussion of the principles of tissue cell culture. This course is presented in the University College program. (Joseph)

MICB 153. Mycology. (3)
First semester, alternate years. Three lectures a week. Prerequisite, MICB B101 or equivalent. An introductory study of classification, morphology and identification of fungi, with special emphasis on human pathogens. This course is presented in the University College program. (Joseph)

MICB 154. Parasitology. (3)
Second semester, alternate years. Three lectures a week. Prerequisite, MICB B101 or equivalent. Systematic review of the morphology, life cycle, disease process and identification of human parasites, with demonstrations of representative forms. This course is presented in the University College program. (Joseph)

For Graduates

MICB 200, 201. Chemotherapy. (1, 1)
Offered in alternate years. Prerequisites, MICB 121 or equivalent; BIOCHEM 111 or equivalent. Lectures which deal with the chemistry, toxicity, pharmacology and therapeutic value of drugs employed in the treatment of disease. (Shay)

MICB 202. Theory and Principles of Reagents and Media. (3)
Offered in alternate years. Consideration of media for special procedures, such as antibiotic assays, blood cultures, spinal fluid, exudates and other materials. Anaerobiosis, differential media, biochemical reactions, sensitivity and sterility testing are considered in detail. Emphasis is placed on growth requirements of specific groups of microorganisms. (Schneider)

MICB 210. Special Problems in Microbiology.
(Credit determined by amount and quality of work performed.) Laboratory course. Special studies in the various divisions of microbiology. (Staff)

MICB 211. Public Health. (2)
Prerequisite, MICB 121 or equivalent. A demonstration of public health facilities in the community and their relation to the practices of the health sciences carried on through lectures and discussion groups. The application of statistical and epidemiological methods to health problems is illustrated through lectures and demonstrations. (Shay)

MICB 212. Bacterial Fermentations. (2)
Second semester, alternate years. Prerequisites, MICB 121 or equivalent; BIOCHEM 111 or equivalent. This course covers composition, nutrition and growth of microorganisms; influence of physical and chemical environment on metabolism; chemical activities of microorganisms; mechanisms of fermentative and oxidative metabolism. (Krywolap)

MICB 221. Advanced Dental Microbiology and Immunology. (4)
First semester. Three lecture hours and three hours of laboratory with group conferences each week. Prerequisite, MICB 121 or equivalent. This course, intended for graduate students of oral microbiology, is a continuation of MICB 121, supplemented with library readings and advanced laboratory experimentation. (Staff)

MICB 224. Microbiology of the Periodontium. (2)
Second semester, alternate years. Prerequisites, MICB 121; HISTOL 111; and PATH 121, or equivalents. This course is designed for advanced students in the field of oral microbiology. Consideration will be given to the role of microorganisms in periodontal tissues and the factors that influence the development of diseases; bacterial interactions; parasitism; salivary calculus; periodontitis; gingivitis; and herpetic gingivostomatitis. (Shay)

MICB 230. Experimental Virology. (4)
Prerequisite, a course in General Virology or equivalent and consent of the instructor. Offered first semester, alternate years. Two lectures and two laboratory periods per week dealing with the molecular biology of viruses. Emphasis will be placed on experimental techniques used to study the physical, chemical and biological properties of viruses and the molecular basis of virus-cell interactions. Areas covered will include techniques used to purify and characterize viruses; fractionation procedures; and methods used to study the *in vivo* and *in vitro* synthesis of viral components. (Delisle)

MICB 235. Bacterial Genetics. (4)
Prerequisite, Microbiology 212 or Microbiology 203 and consent of the instructor. Offered first semester, alternate years. Two lectures and two laboratory periods per week dealing with the genetics of bacteria and bacterial viruses. Areas covered will include induction, expression and selection of mutants; molecular basis of mutations; transfer of genetic information by transformation, transduction and conjugation; complementation and recombination in phage and bacteria; genetic mapping and gene fine structure; and extrachromosomal genetic elements. (Delisle)

MICB 281-283. Seminar. (1) (1)
Presentation and discussion of current literature and research in the field of microbiology. (Staff)

MICB 399. Thesis Research. (Master's Level)
(Credit determined by amount and quality of work performed.) Open only to candidates for advanced degrees in microbiology. (Staff)

MICB 499. Dissertation Research. (Doctoral Level)
(Staff)

ORAL PATHOLOGY

Professors: J. J. Salley, and M. Lunin.
Assistant Professors: T. Beckerman, B. A. Levy, and J. R. Swancar.

For Graduates and Advanced Undergraduates

PATH 121. General Pathology. (4)
Two lectures and two laboratory periods per week for one semester. (Staff)

For Graduates

PATH 212, 213. Special Problems in Oral Pathology. (2, 2)
Prerequisite, PATH 121 or equivalent. One lecture and one laboratory period per week. The histopathology of selected oral lesions with emphasis on recent advances in diagnostic techniques. (Staff)

PATH 214, 215. Methods in Histopathology. (4, 4)
Prerequisite, PATH 121 or equivalent. Two four-hour laboratory periods each week. The laboratory methods used in preparing pathologic tissues for microscopic examition. (Staff)

PATH 216, 217. Advanced Histopathology of Oral Lesions. (3, 3)
Prerequisite, PATH 212 or equivalent. One hour of lecture and four hours of laboratory each week. The study of uncommon and rare lesions of the head and neck. (Staff)

PATH 218, 219. Seminar. (1, 1)
Prerequisite, PATH 121 or equivalent. One period each week. Recent advances in experimental oral pathology. (Staff)

PATH 399. Thesis Research. (Master's Level)
Time and credit by arrangement. (Staff)

PATH 499. Dissertation Research. (Doctoral Level)
(Staff)

ORAL SURGERY

A three year post-graduate program in Oral Surgery leading to American Board of Oral Surgery eligibility. The program is available to dentists graduated from accredited dental schools in the United States and Canada. There are three positions offered each year.

The first year is spent as an intern in the University of Maryland Hospital, rotating between the anesthesia service, and inpatient and outpatient oral surgery clinics. The second year combines teaching in the undergraduate oral surgery clinic, graduate courses in the basic sciences and clinical oral surgery in the post-graduate section of the dental school. The third year, as senior resident, the trainee is given major responsibility for all oral surgery cases operated at University, City, Mercy, Provident and St. Agnes Hospitals.

SURG 201. Clinical Anesthesiology. (6)
First year oral surgery interns assigned to the Department of Anesthesiology for three months. Attends all conferences given by that department and practices clinical anesthesiology in the operating room of the hospital.

SURG 220. General Dental Oral Surgery. (4)
Clinical course for third year residents in oral surgery. Two conferences per week. Residents are evaluated on the way they manage clinical patients during their final year of residency.

PHYSIOLOGY

Professor: White.
Assistant Professor: Bennett.
Instructors: Nardell and Staling.

PHYSIOLOGY 121. F.S. Principles of Physiology. (6)
Three lectures and one laboratory period per week, first semester; two lectures per week, second semester. (White, Staff)

PHYSIOLOGY 211. F.S. Principles of Mammalian Physiology. (6)
Prerequisite, permission from the Department. Same as PHYSIOLOGY 121 but with collateral reading and additional instruction. Each student is required to write a review paper on some special phase of physiology. (White)

PHYSIOLOGY 212. Advanced Physiology.
Second semester. Hours and credit by arrangement. Prerequisite, PHYSIOLOGY 121 or its equivalent. Lectures and seminars on special problems and recent advances in physiology. (White)

PHYSIOLOGY 213. Research.
By arrangement with the Head of the Department. (White)

PHYSIOLOGY 399. Thesis Research. (Master's Level)
By arrangement with the Head of the Department. (White)

PHYSIOLOGY 499. Dissertation Research. (Doctoral Level)

SCHOOL OF MEDICINE

ANATOMY

Professors: Figge and Krahl.
Associate Professors: Donati, O'Morchoe and Wadsworth.
Assistant Professors: Barrett, Petersen, Ramsay, and Rennels.

The graduate degrees offered by the Department of Anatomy are the Doctor of Philosophy and the combined Doctor of Medicine-Doctor of Philosophy degrees. Courses in all phases of anatomy are offered: gross anatomy, including fetal and infant anatomy; microanatomy, including electron microscopy and genetics; and neuroanatomy. The attempts to major in only one of these subdivisions is discouraged. The goal is to produce well-rounded anatomists capable of participating in any phase of anatomical teaching or research.

Beginning students are assigned to a committee of three advisors. The requirements for the degree include taking all the courses offered in the Anatomy Department and 24 credit hours of minor subjects related to the subject of anatomy. In addition, students are required to assist in the teaching of all or most of the courses of anatomy.

For Graduates and Advanced Undergraduates

ANAT 201. General Anatomy of the Human Body. (9)
This course gives the student an opportunity to develop a basic concept of the morphology of the human body. It is closely interwoven with the study of neuroanatomy, histology and embryology, and some time is devoted to roentgen anatomy. The entire human body is dissected. (Figge, Staff)

ANAT 207. Fetal and Infant Anatomy. (2)
Second semester, fifteen periods of three hours each, to be arranged. The course is open to graduate students, medical and postgraduates interested in pediatrics. A maximum of eight students per session. (Krahl)

ANAT 211. Seminar. (1, 1)
Second semester. One session per week. Graduate students, staff and guests participate in comprehensive and critical review of subjects of special interest in the field of anatomy. (Figge, Staff)

ANAT 499. Research in Anatomy. (Doctoral Level)
Maximum credits, 12 per semester. Research work may be taken in any one of the branches of anatomy. (Figge, Staff)

MICROANATOMY

ANAT 202. Microanatomy. (6)
This course presents an integrated study on an advanced level of the histology and embryology of the human body. An attempt is made to correlate this with gross

anatomy as well as other subjects in the medical curriculum. Special emphasis is placed on the dynamic and functional aspects of the subject. (O'Morchoe, Donati)

ANAT 205. Genetics. (2)
The course consists of a series of one-hour lectures which include a consideration of the principles of genetics, population genetics, biochemical genetics, radiation genetics, immunogenetics, and microbial genetics. Special emphasis is placed on the importance, understanding and application of genetics to health and disease. (Petersen)

ANAT 206. Techniques in Electron Microscopy. (2)
Second semester. This course will consist primarily of an introduction to techniques used in electron microscopy in particular with immunological staining techniques. (Donati, Barrett)

ANAT 208. Studies on Normal and Atypical Growth. (2)
Studies of problems of growth. Two hours per week, time to be arranged. Sixteen weeks. (Figge)

ANAT 209. Tissue Culture Techniques. (2)
This course will deal with the techniques and problems in the tissue culture laboratory. It will be linked with the course in electron microscopy. (Barrett, Donati)

MICROANAT 499. Thesis Research.
Maximum credits 12. Research work may be taken in any one of the branches which form the subject of microanatomy (including electron microscopy). (Figge, Staff)

NEUROANATOMY

ANAT 203. Neurological Sciences. (6)
Second semester. Consists primarily of the integrated course of neuroanatomy and neurophysiology with additional contributions from neurology, neuropathology, neurosurgery and electroencephalography. The structure and function of the central nervous system will be presented simultaneously. The course will involve dissection of the human brain, examination of stained microscopic sections of various levels of the brain stem and laboratory experience involving the study of functional aspects of the nervous system. (Nelson, O'Morchoe, Rennels, Wagner)

ANAT 210. Special Problems in Neuroanatomy. (2)
This course will deal with specific problems in the field of neuroanatomy, depending on the interests of the sponsor. It will consist of lectures, seminars and specific laboratory assignments. (Figge, O'Morchoe, Rennels)

NEUROANAT 499. Thesis Research in Neuranatomy. (Doctoral Level)
Maximum credits 12. Research work involving the central or peripheral nervous system. (Figge, Staff)

BIOLOGICAL CHEMISTRY

Professors: Adams, Frank, Lambooy (P.T.), and Pomerantz.
Associate Professors: E. Bucci, and Kirtley.
Assistant Professors: Black, C. Bucci, Gryder, LaBrosse (P.T.), Rao, and Tildon (P.T.)
Instructor: Brown.

For Graduate Students

BIOCHEM 200. Principles of Biochemistry. (5)
First semester. A general introduction to biochemistry with emphasis on basic

chemistry of biologically important molecules, enzymes, intermediary metabolism, metabolic regulation, and molecular biology. Features of mammalian biochemistry are stressed but general and comparative aspects are considered. This is the biochemistry course offered to first year medical students and interested graduate students.

BIOCHEM 201. Principles of Biochemistry and Biophysics. (6)
First semester. Same as Biochem 200 with additional lectures in the principles of biophysics as presented to first year medical students. Graduate credit may be obtained for Biochem 200 or 201 but not both.

BIOCHEM 203 (A-G). Advanced Topics in Biochemistry. (3)
Prerequisite, BIOCHEM 200 or 201 or equivalent. A series of lectures on special topics of current interest in biochemistry. One course will be given each semester with primary emphasis as follows: A) Enzymes; B) Biochemical genetics; C) Biochemical regulation; D) Microbial physiology; E) Physical biochemistry; F) Proteins and amino acids; G) Special topics.

BIOCHEM 204, 205. Seminar. (1, 1)
Reports on current literature or on research in progress. Prerequisite, Biochem 200 or 201 or equivalent.

BIOCHEM 399. Thesis Research. (Master's Level) (Maximum credits, 12 hours per semester)

BIOCHEM 499. Dissertation Research. (Doctoral Level) (Maximum credits, 12 hours per semester)

BIOPHYSICS

Professors: Mullins *(Chairman of Department),* and Sjodin.
Assistant Professors: DeWeer, Geduldig, and Hybl.

The Department of Biophysics offers graduate courses of study leading to the degrees of Master of Science and Doctor of Philosophy. The study programs are flexible and depend on the preparation and interests of the student. Detailed requirements are available from the Department of Biophysics (c/o School of Medicine, Baltimore).

A number of fellowships are available for beginning graduate students; after the first year of graduate study, research assistantships are available. Inquiries should be directed to the Department; deadline for applications is March 1.

It is recommended that students studying for the degree of Doctor of Philosophy in biophysics select a minor in either physics, chemistry or mathematics.

For Graduates and Advanced Undergraduates

BIOPHYS 100D. Introduction to Biophysics. (3)
Fall semester. Three lectures a week. Prerequisites, CHEM 001, 003, PHYS 010, 011. MATH 018, 019. An introduction to the study of living systems applying the methods of physics and chemistry. The cell as a physico-chemical system and experimental methods for investigation, nerve impulse conduction and excitation, the interaction of radiation with living material; the structure and properties of muscle tissue, connective tissue, and their proteins. (Staff)

BIOPHYS 101D. Introduction to Biophysics. (3)
Spring semester. Continuation of Biophys, 100D - given when number of students warrants. (Staff)

BIOPHYS 102D. Biophysics of Radiation. (2)
Fall semester, even years. Two lectures a week. Prerequisites, CHEM 001, 003, PHYS 010, 011. An advanced study of the interaction of radiation with living matter and with molecules of biological interest. Dosimetry problems and some bio-medical applications will be considered. (Mullins, Sjodin, Robinson)

BIOPHYS 103D. Laboratory Techniques in Biophysics. (3)
One lecture and two laboratory periods a week. Prerequisites, BIOPHYS 100D, 101D, or consent of the staff. Training in the use of radioactive isotopes, radioactive counting equipment, and bio-electric measuring instruments applied to the study of membranes; viscosity, optical rotation, protein titrations, spectroscopy, conductivity, as applied to fiber forming proteins. (Staff)

BIOPHYS 104D. Seminar in Biophysics. (1)
Prerequisites, BIOPHYS 100D, 101D, or consent of the staff. Seminars on various biophysical topics given by the staff, graduate students, and guest speakers. (Staff)

For Graduates

BIOPHYS 200D. Advanced and Theoretical Biophysics. (3)
Fall semester, odd years. Three lectures a week. Prerequisites, BIOPHYS 100D, 101D, or consent of staff. An advanced and critical analysis of experimental findings in terms of biophysical theory. (Staff)

BIOPHYS 201D. Membrane Biophysics. (2)
Two lectures a week. Prerequisites, CHEM 001, 003, PHYS 010, 011, MATH 020, 021. Diffusion in and through membranes developed from first principles with special reference to problems of ion transport in biological membranes. (Sjodin)

BIOPHYS 203D. X-Ray Crystallography. (3)
Three lectures a week. An introduction to molecular structure determination by the techniques of X-ray differaction. Emphasis upon problems arising in structural studies of molecules of biological origin. (Hybl)

BIOPHYS 205D. Colloquium in Biophysics. (1)
Prerequisites, BIOPHYS 104 or consent of the staff. Colloquia on various biophysical topics given by the staff, graduate students and guest speakers. (Staff)

BIOPHYS 399D. Thesis Research in Biophysics. (Master's Level)
Required of students planning to take the Master of Science degree in Biophysics. (Staff)

BIOPHYS 499D. Dissertation Research in Biophysics. (Doctoral Level) (Staff)

LEGAL MEDICINE, PATHOLOGY, MEDICAL (TOXICOLOGY)

Professor: Fisher.
Associate Professor: Freimuth.
Assistant Professor: Spitz.

This Department offers schedules leading to the degrees of Master of Science and Doctor of Philosophy in toxicology. Candidates are expected to have completed undergraduate work as follows: eight semester hours each in gen-

eral chemistry, organic chemistry, analytical chemistry (qualitative and quantitative), physical chemistry, physics, biology and four semester hours in organic qualitative analysis.

Candidates for the master's degree must complete the following or equivalent courses:

LEG MED 201, 204, 205, 206, 207, and 399.
PHARM 201 f. s., and PHARM CHEM 210, 211.

Candidates for the doctorate must complete the following or equivalent courses.

LEG MED 201, 204, 205, 206, 207, 499.
PHARM 201 f. s., PHYSIOL 201, BACT 101, BACT 102, PHARM CHEM 210, 211, BIOCHEM 206, CHEM 206, 208, CHEM 221, 223, CHEM 150, PHARM CHEM 151, 152, PHARM CHEM 253, 254.

Part of the above work is offered at College Park with the remainder to be done at the Baltimore Schools. Some of the course work in legal medicine and toxicology will be given at the laboratories of the Division of Forensic Pathology located at the Office of the Chief Medical Examiner, 700 Fleet Street, Baltimore, Md.

LEG MED 201. Legal Medicine. (1)
One hour of lecture for twelve weeks, 4 hours assigned reading. This course embraces a summary of medical jurisprudence including the laws governing the practice of medicine, industrial compensation and malpractice, proceedings in criminal and civil prosecution, medical evidence and testimony, including medicolegal toxicology. (12 hours) (Fisher, Freimuth, Spitz)

LEG MED 204, 205. Toxicology. (5, 5)
Two hours lecture, 8 laboratory hours per week for 1 year. There is also included some discussion of industrial toxicology relating industrial exposures to toxic substances to effects produced in the worker using these materials. The lectures include discussion of mechanism of action of poisons, lethal doses, antidotes and methods of detection and quantitation of poisons in tissues and body fluids. The laboratory work embraces practical application of analytical procedures for the detection and estimation of poisons in post mortem tissue samples. (Fisher, Freimuth)

LEG MED 206, 207. Gross Pathologic Anatomy as Related to Toxicology. (1, 1)
Two hours per week for one year. This course includes elementary anatomy with normal histology and selected histopathology as it will be seen by the toxicologist. It is a correlated course embracing anatomy, basic physiology and the alterations in function as well as structure brought about by disease and poisoning. (Fisher, Spitz)

LEG MED 399. Thesis Research in Toxicology. (Master's Level)
(Number of hours and credit arranged.) (Fisher, Freimuth)

LEG MED 499. Dissertation Research in Toxicology. (Doctoral Level)

MICROBIOLOGY

Professors: Wisseman, and Traub.
Associate Professors: Eylar, Fiset, and Kessel.
Assistant Professors: Myers, Rosenzweig, and Snyder.

The Department of Microbiology offers the degree of Doctor of Philosophy. While the degree of Master of Science may be offered in special instances,

priority for research facilities will be given aspirants to the Doctor of Philosophy degree. This Department encourages students who wish to enroll in the combined Doctor of Medicine-Doctor of Philosophy degree program.

Emphasis is placed upon medical aspects of microbiology. Research programs are available in virology, rickettsiology, medical bacteriology, immunology, and microbial physiology. Opportunities are open for experience in teaching and in diagnostic bacteriology and serology. Opportunities exist for ecological studies on rickettsioses and arboviruses in overseas areas.

For Graduates and Advanced Undergraduates

MICB 101. Medical Microbiology and Immunology. (8)
First semester. Four lecture hours and eight hours in laboratory and group conferences per week. This course begins with an introduction to basic principles of microbiology and immunology and then proceeds to consider the major groups of bacteria, spirochetes, fungi, rickettsiae and viruses that cause human disease. Emphasis is placed upon an analysis of the properties of microorganisms thought to be important in disease production, pathogenesis of infection and interaction with host defense mechanisms, epidemiology and control measures. (Wisseman, Staff)

For Graduates

MICB 201. Medical Microbiology and Immunology. (8)
First semester. Four lecture hours and eight hours in laboratory and group conferences per week. This course, intended for the serious advanced student of medical microbiology, is built upon the framework of MICB 101 supplemented with advanced readings and laboratory work. (Wisseman, Staff)

MICB 203. Microbial Physiology. (3)
Second semester, alternate years. Three lectures per week supplemented with demonstrations. By consent of instructor. This course surveys the metabolic processes of bacteria, fungi, rickettsiae, viruses and parasitic protozoa. (Myers, Wisseman)

MICB 206, 207. Seminar. (1, 1)
First and second semesters. One session per week. Graduate students, staff and guests participate in comprehensive and critical reviews of subjects of special interest or pertinent to graduate training program. (Staff)

MICB 209. Special Topics.
(Permission and credit arranged individually.) This course provides the opportunity for the graduate student to pursue under supervision subjects of special interest not offered in other formal courses. A study program is worked out with the instructor prior to registration and may consist of special readings, conferences, reports and, on occasion, laboratory experience. (Staff)

MICB 210. Advanced Virology and Rickettsiology Lecture. (3)
This course considers the general properties of viruses and rickettsiae, methods for studying them and finally concentrates on agents of medical importance. Special emphasis is placed on the host-parasite relationship, characterization of the various viral and rickettsial agents and on biological and ecological factors. Registration is by permission of instructor only. The course will be given on the average in alternate years in the Spring semester. There are two weekly sessions of 90 minutes each. Prerequisite, MICB 201 or equivalent. (Eylar, Fiset, Wisseman, Staff)

MICB 211. Virology and Rickettsiology Laboratory. (1)
This course is the laboratory counterpart of MICB 210. The laboratory consists of

two formal sessions per week; and frequently requires additional participation throughout the week. Registration is by permission of instructor only.
(Eylar, Fiset, Wisseman, Staff)

MICB 220. Microbiology: Advanced Immunology. (3)
This course will consider in detail areas of immunology that are currently subject to the most active investigation. Special attention will be paid to four areas of immunology; 1) the structures of antigen and antibody molecules and the nature of the interactions between them, 2) the process of antibody formation including the anatomy and physiology of antibody forming tissues, and the nature of the controls on antibody synthesis, 3) immunopathology with special reference to the phenomena of autoimmunity, 4) delayed hypersensitivity reactions with special reference to host resistance and to problems of transplantation immunology. The course will be given on the average every two years in the Spring semester. These will be two weekly sessions of 90 minutes each. Prerequisite, Microbiology 201 and/or permission of the instructor. (Fiset, Kessel)

MICB 221. Microbiology: Advanced Immunology Laboratory. (2)
This course is the laboratory counterpart of MICB 220. The laboratory consists of formal sessions plus the additional participation of students throughout the week. Registration is by permission of the instructor only. (Fiset, Kessel)

MICB 399. Thesis Research. (Master's Level)
Maximum credits, 12 hours per semester. (Staff)

MICB 499. Dissertation Research. (Doctoral Level)
(Staff)

CELL BIOLOGY AND PHARMACOLOGY

Professors: Aposhian, Ludlum, and Ryser.
Assistant Professors: D. B. Brown, N. C. Brown, and Burlingham.

All students majoring in the Department of Cell Biology and Pharmacology with a view to obtaining the degree of Doctor of Philosophy are expected to secure training in mammalian physiology, biochemistry and physical chemistry.

For Graduates and Advanced Undergraduates

PHARMACOL 101, f.s. General Pharmacology. (8)
Three lectures and one laboratory. This course consists of 68 lectures and 5 laboratory periods of three hours each, offered each year.
(Aposhian, Ludlum, Ryser, Brown, Brown, Burlingham)

For Graduates

PHARMACOL 201, f.s. General Pharmacology. (8)
Same as PHARMACOL 101, for students majoring in pharmacology. Additional instruction and collateral reading are required.
(Aposhian, Ludlum, Ryser, Brown and Brown)

PHARMACOL 206, f.s. Pharmacologic Methodology. (4)
Prerequisite, PHARMACOL 201, f.s. (Staff)

PHARMACOL 207, 208. Chemical Aspects of Pharmacodynamics. (2, 2)
(Staff)

PHARMACOL 209. Biochemical Pharmacology. (2)
(Staff)

PHARMACOL 210. History of Pharmacology. (2)
(Staff)

PHARMACOL 211. The Biology of Macromolecules. (4)
Prerequisite, biochemistry. Advanced study of nucleic acids, proteins and their function.
(Staff)

PHARMACOL 499. Dissertation Research. (Doctoral Level)
(Staff)

PHYSIOLOGY

Professors: Blake, Adelman, Barraclough, Pinter, and Shock.
Associate Professors: Fajer, Glaser, Goldman, Karpeles, and Merlis.
Assistant Professors: Blaumanis, Fertziger, Greisman, Haller, and Jurf.

There are three graduate programs available to students interested in physiology: (1) a predoctoral program leading to the Doctor of Philosophy degree; (2) a predoctoral program leading to the Doctor of Philosophy degree with specialization in gerontology; and (3) a predoctoral program leading to Doctor of Medicine and Doctor of Philosophy or Master of Science degrees. Prerequisites include differential and integral calculus, general physics, and chemistry, although one of these may be taken concurrent with the first year of the predoctoral Doctor of Philosophy program. All programs include course work in anatomy, biochemistry and/or biophysics, instrumentation, statistics, and computers. Fellowships and assistantships are available for qualified applicants.

For Graduates and Advanced Undergraduates

PHYSIOL 101. Principles of Physiology. (8)
Second semester. Four lectures, two laboratories, and two conferences per week for 16 weeks. Lectures cover major areas of organ-system physiology except for the nervous system which is embodied in NEUROANAT 101. Laboratory work is classical exercises for 8 weeks and a "project" experiment for 8 weeks. Conferences are on laboratory work. (Staff)

For Graduates

PHYSIOL 201. Principles of Physiology. (9)
Same as PHYSIOL 101, for graduate students majoring in physiology. Additional reading and attendance at departmental seminars are required. (Staff)

PHYSIOL 202. Cardiovascular Physiology. (2)
Reading assignments, seminars, conferences, two hours a week for 15 weeks, on current research in cardiovascular physiology. (Karpeles)

PHYSIOL 204. Physiological Techniques.
Time and credit by arrangement. The various technical procedures currently operating in the Department will be demonstrated and opportunity will be given for acquiring experience with them. (Staff)

PHYSIOL 205. Physiology of Kidney and Body Fluids. (2)
Two hours a week, lectures, seminars and conferences, for 15 weeks. Consideration will be given to the current status of knowledge of renal function and body fluids in vertebrates, with particular reference to mammals. (Blake, Pinter)

PHYSIOL 206. Seminar.
Credit according to work done. Weekly meetings are held to discuss recent literature and results of departmental research. (Staff)

PHYSIOL 207. Physiology of the Central Nervous System. (2)
Two hours a week for 15 weeks. Lectures, seminars and reading assignments on current knowledge of central nervous system function. (Merlis)

PHYSIOL 208. Physiology of the Autonomic Nervous System. (2)
Two hours a week for 15 weeks. Lectures, seminars and reading assignments on current knowledge of autonomic nervous system function. (Jurf)

PHYSIOL 209. General Physiology. (2)
Two hours a week for 15 weeks. Lectures, reading assignments, and seminars on selected topics in general, cellular and neurophysiology. (Adelman)

PHYSIOL 210. Physiological Systems. (3)
Three or four hours a week for 15 weeks. Lectures, conferences, and laboratory sessions on the theoretical principles of biological control systems. (Glaser)

PHYSIOL 212. Physiology of Reproduction. (2)
Lectures, two hours a week for 15 weeks. A comprehensive survey of reproductive endocrinology. (Barraclough)

PHYSIOL 213. Seminar in Neuroendocrinology. (2)
Two hours a week for 15 weeks. Lectures and seminars on recent advances in nervous regulation of endocrine function. (Barraclough)

PHYSIOL 214. Comparative Adrenal Physiology. (2)
Lectures and conferences, two hours a week for 15 weeks, on current knowledge of vertebrate adrenal function. (Fajer)

PHYSIOL 399. Thesis Research. (Master's Level)
By arrangement with Head of the Department. (Staff)

PHYSIOL 499. Dissertation Research. (Doctoral Level)
(Staff)

SCHOOL OF NURSING

Professors: Murphy, Cohelan, and Neal.
Associate Professors: Graffam, Hydorn, Kohl, MacVicar, Mitchell, Ruano, and Schubert.
Assistant Professors: Boyd, Braun, Harvey, Kandlbinder, Lindsey, Lukasik, Manning, Matejski, McDonagh, McGee, Moseley, Muhr, Petrick, Robinson, Scott, Slater, Waltz, and Ward.
Instructors: Froebe, O'Donnell, and Robinette.
Lecturer: DeHoff.

The graduate programs in nursing leading to the Master of Science degree are designed to prepare qualified professional nurses for positions of leadership in nursing. Primary emphasis is placed on preparation for advanced professional practice in one of the following areas: general psychiatric nursing, child psychiatric nursing, medical and surgical nursing, maternal and child nursing, public health nursing, or administration of nursing.

Students who wish to prepare for administration or teaching utilize the minor requirements to secure background in areas of specialized knowledge related to their specific goal. A supervised practicum in the last semester is

required for students preparing for administration or teaching; other students utilize this period to round out clinical specialist preparation. Selected nurses also may secure preparation for executive positions in departments of nursing.

Admission to the graduate program in nursing requires that the applicant be a professional nurse who has completed a baccalaureate degree program with academic standing which is recognized by The Graduate School of the University of Maryland. In general, the applicant should have completed foundational and clinical courses comparable to the requirements of the undergraduate program in nursing at the University. Evidence of personal and professional qualifications are sought through references and, if possible, by an interview. Applications from nurses whose baccalaureate programs were not accredited by the National League for Nursing are subjected to special review with individualized recommendations resulting.

Students who elect the thesis option write a thesis representing research in nursing. Students who choose the non-thesis option write two seminar papers and register for additional course work. One seminar paper may be an extensive review of literature and one paper must be a report of some research in nursing which was undertaken by the student.

Minimum residence of three semesters, or equivalent, is required.

For Graduates

NURS 201. Trends of Higher Education in Nursing. (2)
(Murphy)

NURS 202. Interpersonal Interaction. (2)
(Staff)

NURS 203. Intradisciplinary Nursing. (2)
(Cohelan)

NURS 204, 205. Psychiatric Nursing. (2, 2)
(McManama, Muhr, Kandlbinder, Scott)

NURS 206. Epidemiology. (2)
Prerequisite, Preventive Medecine 158 - Biostatistics or equivalent. (Boyd, Henderson)

NURS 207, 208. Nursing in Child Health. (3, 3)
(Neal, Lukasik)

NURS 209, 210. Maternal and Infant Nursing. (3, 3)
(Hydorn)

NURS 211. Seminar in Maternal and Child Health Services. (2)
(Neal, Hydorn, Lukasik)

NURS 212, 213. Medical and Surgical Nursing. (2, 2)
(Matejski, Harvey, Manning, Braun, Moseley)

NURS 214. Application of Principles of Physical and Social Sciences in Nursing. (2)
Prerequisites, Completion of NURS 212 and 213.
(Matejski)

NURS 220-221. Community Health Nursing. (3, 3)
(Boyd, McGee, Ruano, Waltz)

NURS 222. Public Health Administration. (2)
(McGee, DeHoff)

NURS 247-248. Orientation to Critical Problems in Family-Child Relationships, I and II. (2, 2)
(Petrick, Scott)

NURS 249. Nursing of Pre-school Children with Deviant Behavior. (4) (Staff)

NURS 250-251. Comprehensive Care of Children with Psychiatric Disorder, I and II. (4, 4) (Petrick, Scott, McDonagh)

NURS 285. Curriculum Development in Nursing. (2) (Kohl)

NURS 286. Research Methods and Materials in Nursing. (2) (Mitchell)

NURS 287. Seminar in Nursing: Clinical Specialist, Teaching or Administration. (2) (Staff)

NURS 288. Special Problems in Nursing. (1-6) (Staff)

NURS 289. Process of Administration. (3) (MacVicar, Froebe)

NURS 290. Administration of Nursing. (3) (MacVicar, Froebe)

NURS 291. Practicum in Nursing Administration. (4) (MacVicar, Froebe)

NURS 399. Research: Thesis. (1-6) (Staff)

ANAT 105. Genetics. (2) (Sigman)

ANAT 208. Embryology. (2) (Ramsey)

PHYSIOL 121. Physiology. (4, 2) (Haller, Donati)

SCHOOL OF PHARMACY

Professor: Shangraw.
Associate Professors: Lamy and Allen.
Assistant Professors: Fletcher and Augsburger.

The Department of Pharmacy offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees. The student may specialize in the areas of industrial pharmacy, biopharmaceutics and hospital pharmacy. Graduate students working in this Department must have a degree in pharmacy, and may be required to take some additional undergraduate courses to fulfill specified requirements. Information regarding specific requirements for the degree may be obtained from the Department.

PHARMACEUTICS (PHARMACY)

For Graduates and Advanced Undergraduates

PHARMACY 156. Cosmetics and Dermatological Preparations. (3)
Second semester. Two lectures and one laboratory. Prerequisite, PHARMACY 153. (Allen)

PHARMACY 157. Hospital Pharmacy I. (2)
First semester. Two lectures. Prerequisite, PHARMACY 044. (Lamy)

PHARMACY 158. Hospital Pharmacy II. (2)
Second semester. Two lectures. Prerequisite, PHARMACY 157. (Lamy)

For Graduates

PHARMACY 201, 202. Industrial Pharmacy. (3, 3)
Given in alternate years. Two lectures. A study of manufacturing processes, control procedure and equipment employed in the manufacture of pharmaceuticals on a commercial scale, including new drug applications and the Federal Food, Drug and Cosmetic Act. (Augsburger, Shangraw)

PHARMACY 203, 204. Industrial Pharmacy. (2, 2)
Two laboratories. Prerequisites, PHARMACY 201, 202, or may be taken simultaneously with PHARMACY 201, 202. Laboratory work dealing with the preparation of useful and important pharmaceuticals in large quantities. (Augsburger, Shangraw)

PHARMACY 207, 208. Physical Pharmacy. (2, 2)
Two lectures a week. Prerequisite, consent of the instructor; PHYSICAL CHEMISTRY 187, 188, 189, 190 recommended. A study of pharmaceutical systems utilizing the fundamentals of physical chemistry. (Shangraw and Augsburger)

PHARMACY 211, 212. Survey of Pharmaceutical Literature. (1, 1)
One lecture. Lectures and topics on the literature pertaining to pharmacy, with special reference to the origin and development of the works of drug standards and the pharmaceutical periodicals. (Allen)

PHARMACY 215, 216. Product Development. (2, 2)
Two laboratories. Prerequisites, PHARMACY 201, 202, 208 or permission of instructor. A laboratory course in which the student is required to formulate a medicinal agent into a dosage form and provide all information, including stability data, control procedures, analytical tests, manufacturing and labeling specifications, trade mark and patent application necessary to meet present FDA requirements. (Shangraw)

PHARMACY 230. Pharmaceutical Seminar. (1)
Each semester. Required of students majoring in pharmacy. Reports of progress in research and surveys of recent developments in pharmacy. (Fletcher)

PHARMACY 231, 232. Special Problems in Pharmaceutical Technology. (2, 2)
Two laboratories. A study of technical problems in the stabilization and preservation of pharmaceutical dosage forms and their manufacture. (Staff)

PHARMACY 399. Thesis Research in Pharmacy. (Master's Level)
Credit and hours to be arranged. (Staff)

PHARMACY 499. Dissertation Research in Pharmacy. (Doctoral Level)
(Staff)

MEDICINAL CHEMISTRY

Professor: Zenker.
Associate Professors: Leslie and Krikorian.
Assistant Professors: G. Wright and J. Wright.

The Department of Medicinal Chemistry offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees. The student may specialize in the areas of synthetic medicinal chemistry, natural product chemistry, biochemistry or biophysical chemistry. For graduate study in medi-

cinal chemistry, the student must have a degree in either pharmacy or chemistry. Information regarding specific requirements for the degree may be obtained from the Department.

For Graduates and Advanced Undergraduates

MED CHEM 133, 134. Biochemistry I and II. (3, 3)
First semester, three lectures; second semester, two lectures, one laboratory. A discussion of the physical and chemical properties of the components of living systems and of the metabolic processes in health and disease. Prerequisites, Chemistry 35-38 (Organic Chemistry). (Zenker)

CHEM 141, 143. Advanced Organic Chemistry. (2, 2)
Two lectures. Prerequisites, CHEM 035, 036, 037, 038. An advanced study of the compounds of carbon. (G. Wright)

MED CHEM 151, 152. Chemistry of Medicinal Products. (3, 3)
Three lectures. Prerequisite, MED CHEM 030, 032, 034. A survey of the structural relationships, synthesis and chemical properties, principally of organic medicinal products. (J. Wright)

CHEM 187, 189. Physical Chemistry. (3, 3)
Three lectures. Prerequisites, CHEM 019, 035, 037, PHYS 020, 021 and MATH 020, 021. A study of laws and theories of chemistry, including the gas laws, kinetic theory, liquids, solutions, elementary thermodynamics, thermochemistry, equilibrium, chemical kinetics and electro-chemistry. (Leslie)

CHEM 188, 190. Physical Chemistry. (2, 2)
Two laboratories. Prerequisites, CHEM 187, 189 or may be taken simultaneously with CHEM 187, 189. Quantitative experiments are performed which demonstrate physiochemical principles, and acquaint the student with precision apparatus. (Leslie)

For Graduates

MED CHEM 210, 211. Techniques of Chemical Research. (3, 3)
One lecture, two laboratories. Prerequisites, CHEM 141, 143, 187-190 or concurrent registration. Lectures and laboratory exercises devoted to the systematic separation, characterization and identification of organic structures by chemical and instrumental methods, to the synthesis of organic structures of the more difficult type including isotopically labeled compounds and to isotope counting techniques. (Staff)

MED CHEM 230. Seminar. (1)
Each semester. Required of students majoring in medicinal chemistry. Reports of progress and survey of recent developments in chemistry. (Staff)

MED CHEM 235. Principles of Stereochemistry. (2)
Two lectures. Prerequisite, CHEM 141, 143. A study of the principles of stereochemistry of organic compounds. (G. Wright and J. Wright)

MED CHEM 242. Heterocyclic Chemistry. (2)
Two lectures. Prerequisite, CHEM 141, 143. A study of the chemistry and synthesis of heterocylic compounds. (G. Wright and J. Wright)

MED CHEM 271. Biophysical Chemistry. (2)
Two lectures. Prerequisite, MED CHEM 133, 134, CHEM 189. The application of physical chemical principles to biological systems, and a discussion of the physical properties of biologically important macromolecules. (Leslie)

MED CHEM 272. Selected Topics in Physical Chemistry. (2)
Two lectures. Prerequisites, CHEM 189. A discussion of selected topics of particular interest in the pharmaceutical sciences, including surface chemistry, colloids, kinetics, colligative properties and absorption spectroscopy. (Leslie)

MED CHEM 274. Advanced Physical Chemistry Laboratory. (1)
One laboratory. Prerequisite, CHEM 190. Selected experiments which are necessary for, and a part of, a larger research effort. (Leslie)

MED CHEM 281. Metabolic Inhibitors. (2)
Two lectures. Preerquisite, MED CHEM 133, 134. A discussion of the design, the mode of action of the enzymatic level, and the metabolism of biochemical analogs. (Zenker)

MED CHEM 282. Advanced Biochemistry Laboratory. (2)
Two laboratories. Prerequisite, MED CHEM 281, or permission of instructor. Lab experiments designed to illustrate the use of modern techniques and metabolic methods in the study of drug action and drug metabolism.

MED CHEM 399. Thesis Research in Medicinal Chemistry. (Master's Level)
Credit determined by the amount and quality of work performed. (Staff)

MED CHEM 499. Dissertation Research in Medicinal Chemistry. (Doctoral Level)
(Staff)

PHARMACOLOGY AND TOXICOLOGY

Professors: Kinnard, Ichniowski, and Carr.
Associate Professor: Blake.
Assistant Professors: Buterbaugh, Brown, Chapman, and Louis-Ferdinand.

The Department of Pharmacology and Toxicology offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees. The Department emphasizes the areas of quantitative pharmacology, drug disposition, pharmacodynamics, biochemical pharmacology and toxicology. Students with a degree in pharmacy are preferred; however, students with a strong background in both chemistry and biology are also considered for graduate study in pharmacology. Information regarding specific requirements for the degree may be obtained from the Department.

For Graduates and Advanced Undergraduates

PHARMACOLOGY 145, 146. Pharmacodynamics I and II. (3, 4)
Fourth year, three lectures first semester; three lectures and one laboratory second semester. Prerequisites, PHARMACOLOGY 031, 032 and PHARM CHEM 133, 134 or consent of the instructor. A comprehensive study of pharmacodynamics leading to the rational therapeutic application of drugs.

For Graduates

PHARMACOLOGY 201, 202. Methods of Biological Assay. (4, 4)
First and second semesters. Laboratory and conferences. Prerequisite, PHARMACOLOGY 171. A study of the more important unofficial methods used in the quantitative evaluation of therapeutic substances. (Staff)

PHARMACOLOGY 211, 212. Special Studies in Pharmacodynamics. (4, 4)
First and second semesters. Laboratory and conferences. Prerequisites, PHARMACOLOGY 155, 156 and the approval of the instructor. Offered in alternate years. A study of methods used in the evaluation of drug action. (Staff)

PHARMACOLOGY 221, 222. Special Studies in Biological Assay Methods. (2-4, 2-4)
Credit according to the amount of work undertaken after consultation with the instructor. First and second semester. Laboratory and conferences. Prerequisite, PHARMACOLOGY 171, 201, 202. Special problems in the development of biological assay methods. (Staff)

PHARMACOLOGY 230. Principles of Biochemical Pharmacology. (3)
Two lectures. Laboratory work consists of eight six-hour periods. Second semester. Prerequisites, PHARM CHEM 149, 282 and PHARMACOLOGY 155, 156 or equivalents and consent of the instructor. A study of the biochemical mechanisms involved in drug action with primary emphasis on drug metabolism. (Staff)

PHYSIOL 245. Cellular Physiology and Cytogenetics. (3)
First semester, three lectures. Prerequisites, PHARM CHEM 149, PHYSIOL 142, consent of instructor. The lectures will relate to the physical and chemical properties of protoplasm to the functional problems of the plasma membrane, cytoplasm, golgi apparatus, microsomes, nucleus, mitochondrial structure and their contributions to the integrated cellular activity. The physical and chemical phenomena of cell division and inheritance will be discussed. (Staff)

PHYSIOL 246. Radioisotope Techniques. (3)
Second semester, one lecture and two laboratories. Prerequisite, consent of instructor. A course concerned with the practical use of isotopes particularly as tracers in metabolic investigations. (Staff)

PHARMACOLOGY 399. Thesis Research in Pharmacology. (Master's Level)
Properly qualified students may arrange with the instructor for credit and hours. (Staff)

PHARMACOLOGY 499. Dissertation Research in Pharmacology. (Doctoral Level)
(Staff)

PHARMACOGNOSY

Professors: Blomster, and Slama.
Assistant Professor: Rosler.
Instructor: Hodge.

The Department of Pharmacognosy offers a graduate program leading to the Master of Science and Doctor of Philosophy degrees. The student may specialize in the areas of phytochemistry, chemotaxonomy, biosynthesis, fermentation, plant tissue culture, and plant culture. Graduate students in pharmacognosy must have a Bachelor of Science degree in pharmacy, chemistry, biology, or related areas.

Information regarding specific requirements for the degrees may be obtained from the Department.

For Graduates and Advanced Undergraduates

PHARMACOGNOSY 101, 102. Taxonomy of the Higher Plants. (2, 2)
Given in alternate years. One lecture and one laboratory. Prerequisite, PHARMACOGNOSY 041, 042. A study of the kinds of seed plants and ferns, their classification, and field work on local flora. Instruction will be given in the preparation of an herbarium. (Slama)

PHARMACOGNOSY 111, 113. Plant Anatomy. (2, 2)
Two lectures a week. Prerequisites, PHARMACOGNOSY 041, 042. (Slama)

PHARMACOGNOSY 112, 114. Plant Anatomy. (2, 2)
Two laboratory periods a week. Prerequisites, PHARMACOGNOSY 041, 042; PHARMACOGNOSY 111, 113. Laboratory work covering advanced plant anatomy with special emphasis placed on the structure of roots, stems, and leaves of vascular plants. (Slama)

For Graduates

PHARMACOGNOSY 201, 202. Advanced Study of Vegetable Powders. (4, 4)
Given in alternate years. Two lectures and two laboratories. Prerequisites, Approval of instructor. A study of powdered vegetable drugs from the chemotaxononic and microchemical standpoint. Emphasis will be placed on the screening of phytochemical constituents and their relationship to phytogeny. (Blomster)

PHARMACOGNOSY 211, 212. Advanced Pharmacognosy. (4, 4)
Two lectures and two laboratories. Prerequisites, PHARMACOGNOSY 41, 42, or approval of instructor. A study of the major classes of phytochemical constituents with special attention given to the problems of isolation, identification and biosynthesis of these components. (Blomster)

PHARMACOGNOSY 399. Research in Pharmacognosy. (Master's Level)
Credit according to the amount and quality of work performed. (Staff)

PHARMACOGNOSY 499. Research in Pharmacognosy. (Doctoral Level)
(Staff)

For Graduates and Advanced Undergraduates

MICB 146. Serology, Immunology, Public Health and Parasitology. (4)
Prerequisite, MICB 041 or its equivalent. Two lectures and two laboratories. A study of the principles of immunity, including the preparation and use of biological products employed in the prevention and treatment of infectious diseases. Attention is given to hypersensitivity of humans and animals. Part of the course is devoted to the study of public health. Time is given to the study of medical parasitology, pathology and parasitic infections. (Staff)

INSTITUTIONAL PHARMACY

The Institutional Pharmacy program aims at the education of pharmacists to function primarily in the clinical environment, interacting with other health professionals. Course work will utilize to a large extent those courses offered in the School of Medicine such as clinical pathology, statistics, computers, etc., in addition to the established courses in the pharmacy curriculum. Additionally, those involved in the program will participate in a training program encompassing several hospitals in the Baltimore area.

SCHOOL OF SOCIAL WORK AND COMMUNITY PLANNING*

Professors: Falck, Lewis, Steiner, Thursz, and Upham.
Associate Professors: Bechill, Buttrick, Chiaklin, Fogelson, Goldmeier, Nucho, Palley, Sterne, Trader, and Young.
Assistant Professors: Bennett, Beschner, Berman, Borom, Cacace, Carroll, Citron, Cole, Dockhorn, Ephross, Flomenhaft, Fandetti, Gavin, Gutches, Haas, Heriot, Hersey, Hollander, Jones, Kahn, Kohles, Kelley, Kostick, Kraft, Lebowitz, Makofsky, Maxwell, Mitchell, Miller, Moses, Moulton, Press, Simmons, Taylor, Steingraph, Willis, and Wilson.
Instructors: Neilson, McCuan, Meyer, and Siegel.
Lecturers: Arnold, Black, Coston, Gerstman, Holland, L. Levin, Lisansky, McElhaney, Mitchell, Mittleman, Novey, and Whitt.

For Graduates

SOCIAL POLICY AND SOCIAL SERVICES

SOWK 200. Social Services and Social Policy I. (2)
First semester, first year. An intensive introduction to the emergence of social welfare programs in the United States and the political, social, and economic forces affecting their development. Introduction of basic concepts for the identification of social needs and analysis of social policy in selected fields of social welfare. Examination of the past and present contribution made by social work to the initiation and development of social policy. Open to qualified part-time students with consent of the instructor. (Bechill, Buttrick, Lewis, McCuan)

SOWK 201. Social Services and Social Policy II. (2)
Second semester, first year. Identifies various approaches and examines the development of income maintenance programs as related to social work practice. Approaches to income maintenance are viewed within prevailing attitudes and definitions of poverty and the socio-economic context of the period. Particular emphasis is given to analyzing the role of the social insurances, public assistance, and alternative and supplemental approaches to present income maintenance programs. Prerequisite, SOWK 200. (Bechill, Buttrick, Lewis)

SOWK 202. The Social Work Profession. (2)
Second year. The historical background and development of the profession. Current trends in professional practice. Professional concerns with social policy. Professional values and ethical behavior. (Bechill, Buttrick, Thursz, Young)

SOWK 203. Community Social Welfare Services. (2)
First semester, concurrent with SOWK 200. Participant observation of community provision for control of selected social problems: dependency, disordered behavior, indigent disability. Consideration of social work roles in alleviation and control of selected problems. Open to qualified part-time students enrolled in SOWK 200. (Lewis)

SOWK 204. Social Welfare and the Law. (2)
The law as a means of social control; special needs of the poor for legal services; problems of social and legal agencies in this profession; interdisciplinary sociolegal problems. (Fogelson)

*New title as of July 1, 1970

SOWK 205. Social Welfare History. (2)
The changing concept of charity from Biblical to modern times. Origin of English and American poor laws. Charity organization and the growth of voluntary efforts. Origins and development of welfare state concept. Open to qualified part-time students with consent of instructor. (Arnold, Lewis)

SOWK 206. Community Mental Health. (2)
Historical development of services for the mentally ill and the mentally retarded. Relationship of programs to public health, public medical care, social insurance, and vocational rehabilitation. Legislation concerning mental health and mental illness. Federal, State, and local responsibilities in community mental health. Role of voluntary agencies. Open to part-time students with approval of the instructor.
(Palley)

SOWK 208. Legislative Process and Social Welfare. (2)
Loci of political power in a pluralistic society with representative government. Horizontal and vertical controls of political power, governmental structure and financing affecting inter-governmental relations in social welfare. Role of social workers in social action. Prerequisite, SOWK 201 and consent of instructor. (Berman)

SOWK 209. Economic Issues in Social Welfare. (2)
An examination of the formulation of social welfare policy with special reference to relevant economic issues. The consequences of economic growth and change, automation and structural change, relation of fiscal policy to financing of social welfare programs, are considered within the context of economic and social planning. Concern is with policy issues, implementation of rational solutions, knowledge required for predicting the consequences of policy. Prerequisite, SOWK 201 and consent of instructor. (Buttrick)

HUMAN BEHAVIOR AND THE SOCIAL ENVIRONMENT

SOWK 210. Human Behavior I. (2)
First semester, first year. Study of normal personality development in the culture, birth through the oedipal period, utilizing behavioral and social science theories, especially ego psychology. The course emphasizes the maturation process or biological unfolding, and the developmental process resulting from learning through interaction of the individual with the environment, together with the effects of different learning experiences on personality development. These effects include interruptions in development which may set in motion pathological processes.
Attention to the family as a social system and the social roles of family members in the patterning of relationships. (Lebowitz, Mittleman, Trader, Upham)

SOWK 211. Human Behavior II. (2)
Second semester, first year. The course continues to teach theories selected for relevance and usefulness for social work practice. Ego, social systems and role theories are utilized to study normal personality development, latency through old age, with special attention to role learning and the effects on adult functioning of the systems of family, school, peer groups, and work. Examination of dynamic relationships between normal development and pathology is carried forward.
(Lebowitz, Mittleman, Trader, Upham)

SOWK 212. Human Behavior III. (1)
Descriptive and dynamic considerations in psychosocial disorders and psychopathology likely to be encountered in social work practice, i.e., indigency, marital disorder, delinquent and criminal behavior, personality disorders, retardations, illegitimate parenthood, child neglect and placement, neuroses, and psychoses.
(L. Levin, Mittleman, Upham)

SOWK 213. Human Behavior IV. (2)
Understanding of family dynamics for social workers. The course examines the development, structure and functioning of the family system with emphasis on the understanding and use of various theoretical formulations regarding family dynamics associated with emotional disturbances or symptoms. (Novey)

SOWK 214. Nature and Ecology of Health and Illness. (1)
Introduction to causes, symptoms, treatment, distribution, prevention, and control of disease. Social and psychological aspects of illness, emphasizing factors influencing response to stress. Socio-economic problems of health care. Coordination of health and social resources as relevant to social work practice. (Lisansky)

SOWK 215. Behavior of Human Groups. (2)
Examination of concepts underlying social work practice as drawn from theory of social systems. Special reference to families, small groups, neighborhoods, communities, to social institutions and to culture. Reference also to leadership theory and related formulations useful in understanding interpersonal relationships in families, committees, clubs, social agencies and special interest groups. Open to qualified part-time students with consent of instructor.
(Chaiklin, Holland, Makofsky, Trader)

SOWK 216. Advanced Psychopathology. (2)
A second year elective course designed to provide the students with a knowledge of advanced psychopathology with particular emphasis on psychodynamic formulations through an optimal balance of clinical and didactic material. (Witt)

SOWK 217. Theories of Personality for Social Work. (2)
A second year elective course aimed at deepening the student's ability in comparing and contrasting personality theories, using for this purpose an evaluative frame of reference regarding applicability for social work. The content emphasis will vary with the expertise of the faculty teaching the course and with the interest of students.

SOCIAL WORK PRACTICE
CLINICAL PRACTICE

SOWK 220, 221. Social Casework I, II. (2, 2)
Basic concepts and principles of casework as a social work method. Nature of therapeutic relationships. Principles of communication. Diagnostic assessment of the person-problem-situation configuration. Goal-setting process. Ego-supportive procedures and use of community resources. Casework method appropriate in working with the chronically deprived, multi-problem families. Prognosis, termination, evaluation of outcomes. (Falck, Flomenhaft, Gavin, Goldmeier, Hass, Kostick, Nucho)

SOWK 222. Social Casework III. (2)
Social Casework with children, parent-child problems, marital conflict. Family therapy. Work with families having specific problems (mental retardation, mental illness, physical disability, aging, terminal illness, etc.)
(Flomenhaft, Goldmeier, Haas, Nucho)

SOWK 223. Social Casework IV. (2)
Comparative treatment theories for social casework practice. Psychoanalytically oriented casework compared to and contrasted with the socio-behavorial approach, existentialist approaches, socialization models, and others.
(Flomenhaft, Goldmeier, Haas, Nucho)

SOWK 235. Group Methods in Social Work. (2)
Elementary concepts of social group work essential for the planned use of groups as a resource and therapeutic use of groups in a variety of social work settings. Application of theories of group behavior to understanding committee and other group processes within social agencies and professional and related organizations. Open to qualified part-time students with consent of instructor. Prerequisite, SOWK 215.
(Black, Ephross, Falck, Kahn, Kraft)

SOWK 236. Group Methods in Clinical Social Work. (2)
This is an advanced offering emphasizing social work in groups as practiced in hospitals, mental health centers, counseling agencies, and institutions. The approach is conceptual with reference to social work practice. Prerequisite, SOWK 235.
(Falck)

SOCIAL STRATEGY PRACTICE

SOWK 240. Community Organization I: Community Organization as a Social Work Method. (2)
Community Organization as a social work method. Understanding of theory and basic concepts underlying professional intervention. Identifying and exploring various role models and strategies appropriate to Community Organization practice. Analysis of the dynamics of community change and professional methodolgy to influence change at various levels: neighborhood, community, region, and state. Particular emphasis is given to the processes involved in study, diagnosis, goal setting and development of planned action. This course which is required of all students is the first in the sequence of Community Organization courses.
(Beschner, Frankel, Fogelson, Simmons, Steingraph)

SOWK 241. Community Organization II: Community Organization in Neighborhoods. (2)
Community Organization as a professional method applied to urban neighborhoods with particular reference to low income life styles. The use of citizen participation and indigenous leadership. Alternative approaches to understanding and developing viable action systems at the neighborhood level, and their relation to external systems and forces to affect environmental and service changes. Particular emphasis is given to the distinction between conflict and consensus orientations. The differential role of the worker, based on the diagnosis of the strength of the community, is stressed. SOWK 240 is a prerequisite to this course which is the second of the Community Organization sequence courses. Required of all social strategy students it may be elected by others who meet the prerequisite requirement. (Borom, Cole, Simmons)

SOWK 242. Community Organization III: Community Organization as Interorganizational Work. (2)
Community Organization practice problems in initiating, maintaining or terminating interorganizational programs in social work. Specific cases covering a range of coordinating efforts will be examined in the light of social forces affecting such programs. Major issues in existing interorganizational efforts and alternative models of practice will be explored. SOWK 240 and SOWK 241 are prerequisites to this course which is the third in the Community Organization sequence. It is required of all social strategy students and may be elected by others who meet the prerequisite requirements.
(Fogelson, Makofsky, Simmons, Steingraph)

SOWK 243. Community Organization IV: Social Planning. (2)
An examination of social planning as a form of community organization practice in social work. Exploration of planning as a change technique; the relationship between social planning, physical and/or city planning. Consideration of role models, strategies

and techniques appropriate to social planners. Comparison of social planning with other community organization approaches to social change. Integration and application of relevant theoretical concepts. SOWK 243 is the fourth course in the community organization sequence. SOWK 240, SOWK 241, and SOWK 242 are prerequisites to this course. SOWK 243 is required of all social strategy students and may be elected by others who meet the prerequisite requirements. (Fogelson, Thursz)

SOWK 237. Group Methods for Social Strategy. (2)
This is an advanced offering emphasizing the use of group methods in community organization and development, neighborhood work, urban and rural social planning, and administration. The central core is emphasis on theory and practice of decision-making in task oriented groups. Prerequisite, SOWK 235. (Ephross)

ADMINISTRATION PRACTICE

SOWK 250. Social Welfare Administration. (2)
Second year. Elementary concepts of administration applicable to social welfare agencies. Staff participation in decision-making, policy formulation, and communication. Role relationships within administrative structures. Open to qualified part-time students with consent of instructor. (Bechill, Cacace)

RESEARCH

SOWK 260. Social Work Research I. (2)
Second semester. Methods of research in social work. Problem formulation, data collection and analysis, presentation of findings, and conclusions. Attention to classic and recent studies. The relationships of research to social work knowledge. Open to qualified part-time students with consent of instructor.
(Chaiklin, Ephross, Lewis, Miller)

SOWK 261. Social Work Research II. (2)
An examination of selected basic methodologies used in research and social work practice, e.g., causal analysis and observation. Social work studies, related social science research, and practice experience reports are used to develop methodological skill and an understanding of the relationship between research methods and practice activities. Open to qualified part-time students with consent of instructor. Prerequisite, SOWK 260. (Chaiklin, Ephross)

SOWK 262. Social Work Research III. (2)
Research methodology related to evaluation research is considered through an examination of evaluative procedures, review of studies, and design exercises. Special attention is given to considering ways in which research findings become applied in practice. A major paper is required to be written by the student on this subject. Open to qualified part-time students with consent of instructor. Prerequisite, SOWK 261. (Chaiklin, Ephross)

SOWK 266. Research Project.
(Staff)

FIELD INSTRUCTION

SOWK 280, 281. Field Work: Basic Clinical Social Work Practice. (4, 4)
Both semester, first year. Placement in community agencies for practice instruction in clinical social work methodologies.
(Carroll, Citron, Gutches, Heriot, Hollander, Jones, Kohles, Mitchell, Moulton, Taylor, Willis)

SOWK 282, 283. Field Work: Advanced Clinical Social Work Practice. (5, 5)
Both semesters, second year. Placement in community agencies for practice instruction in clinical social work methodologies. (Bennett, Gavin, Kelly, Kraft, Maxwell)

SOWK 285, 286. Field Work: Basic Social Work Practice in Social Strategy. (4, 4)
Both semesters, first year. Placement in community agencies for practice instruction in social strategy methodologies. (Cole, Meyer, Moses, Wilson)

SOWK 287, 288. Field Work: Advanced Social Work Practice in Social Strategy. (5, 5)
Both semesters, second year. Placement in community agencies for practice instruction in social strategy methods. (Beschner, Cole, Makofsky, Simmons, Wilson)

SPECIAL INSTRUCTION

SOWK 290. Special Social Work Problems. (1-3)
Individually planned study of selected substantial area of professional interest as arranged to meet special needs. Extensive reading, written and oral reporting as arranged by instructor.
(Arnold, Bechill, Coston, Press, Gerstman, Lazarus, L. Levin, Lisansky, McElhaney, Mitchell, Young)

HEALTH SCIENCES
COMPUTER CENTER (BALTIMORE)

CMSC 190. 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. (Staff)

E. Introduction to Biostatistics and Computer Processing I.

F. Introduction to Biostatistics and Computer Processing II.

UNIVERSITY OF MARYLAND, BALTIMORE COUNTY (UMBC)

APPLIED MATHEMATICS

Professors: Aziz, Bhatia, Gross, Roberts *(Chairman)*, Haber *(Visiting)*.
Associate Professors: Campolattaro, Lynn, Parr.
Assistant Professors: Franklin, Horelick, Winston.

The Mathematics Division offers programs leading to the M.S. and Ph.D. degrees in Applied Mathematics.

Divisional regulations concerning admission to graduate study, requirements for the master's and doctor's degrees, qualifying and comprehensive examinations, graduate student support and other matters, have been assembled for the guidance of prospective students. Copies of these regulations are available from the Graduate Committee of the Division of Mathematics.

For Graduates and Advanced Undergraduates

MATH 0411. Linear Algebra. (3)
Finite-dimensional vector spaces. Linear transformations, matrices. Multilinear algebra. Applications. (Bhatia)

MATH 0413. Abstract Algebra. (3)
Sets and mappings. Groups, subgroups, homomorphisms, Sylow and Cayley theorems. Rings and ideals. Euclidian rings, polynominal rings, extension fields, Galois Theory. Prerequisite: MATH 0252. (Franklin)

MATH 0419. Introduction To Number Theory. (3)
Rational integers, divisibility, prime numbers, modules and linear forms, unique factorization theorem, Euler's function, Möbius' function, cyclotomic polynominals, congruences and quadratic residues, Legendre's and Jacobi's symbol, reciprocity law of quadratic residues, introductory explanation of the method of algebraic number theory. Prerequisite: MATH 0252. (Gross)

MATH 0421. Topology. (3)
Sets and functions, metric spaces, topological spaces, derived topological spaces, separation axioms, generalizeed convergence, covering properties and compactness, connectedness, metrizibility, complete metric spaces, introduction to homotopy theory. Prerequisite: MATH 0261-0262. (Horelick)

MATH 0423. Differential Geometry. (3)
Theory of curves and surfaces. Riemannian geometry. Differential forms on manifolds. Prerequisite: MATH 0252. (Franklin)

MATH 0431-0432. Advanced Calculus. (3,3)
Real number system, open sets and compact sets on the real line, limits and continuity of real valued functions of one real variable, differentiation, functions of bounded variation, Riemann-Stieltjes integration, sequences and series of functions, functions of several variables, Differentiable transformations, implicit function theorem, manifolds, exterior algebra and differential forms. Prerequisite: MATH 0252. (Winston)

MATH 0433. Complex Analysis. (3)
Complex number plane and functions of a complex variable, differentiability and analyticity. Riemann surfaces, integration in the complex plane, Cauchy's Theorem, power series, analytic continuation, calculus of residues, meromorphic and entire functions. Prerequisite: MATH 0252. (Gross)

MATH 0435. Introduction To Ordinary Differential Equations. (3)
Existence and uniqueness. Linear equations. Stability. Geometric theory in two dimensions. Bifurcation theory. Equations in the complex domain. Prerequisite: MATH 0431. (Winston)

MATH 0437. Introduction To Partial Differential Equations. (3)
Quasi-linear first-order equations, Lagrange's method, linear second-order equations and their classification, self-adjoint operators, Sturm-Liouville problems and eigenfunction expansions, Green's functions, boundary and initial value problems for potential, wave and heat equations. Prerequisite: MATH 0325. (Lynn)

MATH 0439. Introduction To Functional Analysis. (3)
Operators, review of algebraic systems and algebras. Banach spaces and Hilbert spaces, finite-dimensional spectral theory. Prerequisite: MATH 0431. (Aziz)

MATH 0441. Introduction To Measure and Integration. (3)
Daniell integral, measurable functions, measure of a set, Lebesque-Stieltjes integral,

absolute continuity, Radon-Nikodym theorem, signed measure, Riesz representation theorem. Prerequisite: MATH 0431. (Aziz)

MATH 0475. Numerical Analysis. (3)
Linear systems and matrix inversion, iterative solution of non-linear equations, eigenvalues and eigenvectors, polynominal approximation, numerical differentiation and integration, non-polynominal approximation, numerical solution of ordinary differential equations. Prerequisite: MATH 0210-0252. (Parr)

For Graduates

MATH 0611-0612. Abstract Algebra I, II. (3, 3)
Groups, subgroups, factor groups, homomorphism theorems, rings, ideals, factorization theory for Euclidean rings. Modules over ring of operators, normal form for matrices. Tensor and Grassman algebras. Prerequisite: MATH 0413 or equivalent. (Franklin)

MATH 0621-0622. Topology I, II. (3, 3)
Fundamental group, covering spaces, simplicial homology, simplicial approximations, manifolds. Homology and chronology of topological spaces, plus additional topics to be chosen by the instructor. Prerequisite: MATH 0421. (Bhatia)

MATH 0623. Differential Geometry. (3)
Elementary manifold theory, differential forms and the DeRham theorem, first and second fundamental forms for surfaces, curvature and the Gauss-Bonnet theorem, embedded surfaces. Prerequisite: MATH 0411-0421. (Franklin)

MATH 0624. Differential Topology. (3)
Introduction to differential topology. Differentiable manifolds, immersion and embedding theorems, vector bundles, characteristic classes; other possible topics include cobordism, piecewise-linear and differentiable structures, Morse theory. Prerequisite: MATH 0431-0432. (Staff)

MATH 0631-0632. Real Analysis I, II. (3, 3)
Elements of the theory of metric spaces, category and Bair Theorem. Lebesque integration, absolute continuity and differentiation of functions of bounded variation. Abstract measure theory, Radon-Nikodym and Fubini Theorems, L^p spaces. Elements of Banach spaces, Hahn-Banach and closed graph theorems. Topics on linear transformations of L^p spaces. Prerequisite: MATH 0431. (Aziz)

MATH 0633-0634. Complex Analysis I, II. (3, 3)
Analytic functions, Riemann surfaces, Cauchy's theorem, singularities, residues, contour integrals, conformal mapping, Schwartz-Christoffel transformation, series and sequences, analytic continuation, harmonic functions, Dirichlet problem, uniformization, quasi-conformal mapping, Fourier and Lapace transforms. Singular integral equations. Prerequisite: MATH 0431. (Gross)

MATH 0635-0636. Functional Analysis I, II. (3, 3)
General theory of bounded and unbounded operations in Hilbert space. Applications to quantum field theory, general theory of linear topological spaces. Locally convex spaces, duality; category theorems, ordered spaces. Distributions and generalized functions; tensor products and kernels; applications. Prerequisite: MATH 0411-0431. (Staff)

*MATH 0637-0638. Ordinary Differential Equations. (3, 3)
General properties of differential equations. Two-dimensional systems. Linear systems

*These courses are being considered for inclusion in the curriculum for the Academic Year 1971/72.

and linearization. Perturbations of noncritical linear systems. Simple ocillatory phenomenon and the method of averaging. Behavior near a periodic orbit. Integral manifolds of equations with a small parameter. Periodic systems with a small parameter. Functional equations. The direct method of Lyapunov. Prerequisite: MATH 0411-0431. (Bhatia)

*MATH 0639-0640. Partial Differential Equations. (3, 3)
Calculus of L_2 derivates, elliptic operators, local and global existence theory, regularity properties of solutions of strongly elliptic equations, eigenvalue problems for elliptic equations, completeness of the eigenfunction. Prerequisite: MATH 0631-0632 or equivalent. (Aziz)

*MATH 0641-0642. Hilbert Space and Spectral Theory. (3, 3)
Abstract Hilbert Space and applications. Linear operators, spectral theorem for self-adjoint operators, applications to ordinary partial and integral operators. Prerequisite: Consent of instructor. (Staff)

*MATH 0643-0644. Dynamical Systems. (3, 3)
Elementary notions of trajectories, limit sets and prolongations. Recursive concepts, minimal sets. Dispersive concepts, parallelizable systems. Stability and attraction. Flow near compact invariant sets. Higher prolongations. Differential dynamical systems. Structural stability. Prerequisite: Consent of instructor. (Bhatia)

MATH 0651-0652. Applied Mathematics I, II. (3, 3)
General mathematical theory of partial differential equations and methods of solution with application to physical problems. Topics include single equations of first order, characteristic surfaces and classifications of equations of higher order and systems of equations; properties of hyperbolic, parabolic, and elliptic equations, boundary conditions and well-posed problems; the application of integral transform and other methods for their solutions. Asymptotic approximations. Integral equations, singular integral equations, Wiener-Hopf method, dual integral equations. Riemann Problem, Calculus of variations. Prerequisite: MATH 0431-0432 or equivalent. (Aziz, Lynn)

MATH 0653-0654. Applied Mathematics III, IV. (3, 3)
Probability in function space, the theory of partial differential equations of evolution and infinite-dimensional representation of continuous groups. Special emphasis on application to a rigorous development of scattering theory, constructive quantum field theory; representations of the Lorentz group and its extensions. Prerequisite: Consent of the instructor. (Staff)

*MATH 0655-0656. Fluid Dynamics I, II (3, 3)
Navier-Stokes equations. Energy and vorticity theorems. Incompressible flow and potential theory. Free boundary problems. Inviscid compressible flow theory. Hodograph transformation. Characteristics and shocks. Similarity laws. Exact solutions for viscous flows. Low-Reynolds-number approximate solutions, Boundary layer theory, Stability and turbulence. Rotating and stratified fluids. Prerequisite: Consent of instructor. (Lynn, Roberts)

*MATH 0657. Advanced Analytical Mechanics (3)
A review of the concept of manifold, vector bundles and calculus on manifolds, the qualitative study of analytical mechanics for which the phase space of classical mechanics is generalized in a symplectic manifold. The symplectic algebra, its globalization, Hamiltonian and Lagrangian systems. Canonical transformations. Groups of symmetries and integral invariants. Concept of stability. Prerequisite: Consent of instructor. (Staff)

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*These courses are being considered for inclusion in the curriculum for the Academic Year 1971/72.

*MATH 0659-0660. General Relativity (3, 3)
Review of concepts of topology. Tensor analysis and differential geometry. Mathematical, physical and philosophical assumptions in General Relativity. Structure of the Einstein Field equations and formulation of the initial-value problem. The interior and exterior Schwartzschild solutions. Introduction to relativistic cosmology and astrophysics. The Brans-Dicke theory of graviation and other graviation theories of non-Einsteinian type. The theory of group of motions and the classification of Einstein Spaces. Review of the unified theories of graviation and electro-magnetism. Prerequisite: Consent of instructor. (Campolattaro)

MATH 0661. Calculus of Variations (3)
The fundamental problem of the calculus of variations, absolute and relative extrema, necessary conditions for extrema, the invariance of the Euler equation, the existence of extremals, theory of fields, the Weier-Strass E function, the Jacobi condition, Hamilton-Jacobi theory, Direct methods of calculus of variations, Tonelli's theorem. Prerequisite: Consent of instructor. (Roberts)

MATH 0662-0663. Theory of Probability and Stochastic Process (3, 3)
Random variables and expectations. Law of large numbers, fluctuation theory, recurrent events, Markov chains, zero-one laws of Borel-Cantelli and Kilmogorov. Chebyshev's and Kolmogorov's equalities. Distribution functions and transforms. Random walks, Poisson's processes, Brownian motion and diffusion. Connection with differential and integral equations. Prerequisite: Consent of the instructor. (Staff)

MATH 0665-0666. Group Theory With Applications (3, 3)
Theory of groups and their representations. Discussions of point, rotation, space, Lorentz and Lie groups. Applications to various branches of Physics. Prerequisite: Consent of the Instructor. (Staff)

*MATH 0667-0668. Advanced Numerical Analysis (3, 3)
Approximation theory, positive matrices and their spectral propertiees, applications to iterative methods, over-relaxation. Non-linear systems of equations, Newton methods, global existence and convergence theorems. Solution of ordinary differential equations, Dalquist theory of stability. Initial value roblems for partial differential equations, Lax-Richtmyer theorem, the Dreiss matrix theorem, stability considerations. Boundary value problems, variational methods. Prerequisite: Consent of instructor. (Parr)

*MATH 0669-0670. Control Theory (3, 3)
Optimal control of linear systems and linear processes with integral cost criteria, the maximum principle and necessary and sufficient conditions. Controllability, observability and stability. Synthesis of optimal controllars for some basic nonlinear control processes. Optimal processes governed by functional and partial differential equations. Steepest descent and other computational techniques. Prerequisite: Consent of instructor. (Bhatia, Aziz)

*MATH 0671-0672. Perturbation Methods I, II (3, 3)
Uniformly valid approximate solution of ordinary and partial differential equations. Problems with multiple time scales. Poincare's method. Averaging methods of Krylov and Bogoliubov. Turning point problems. Coordinate straining techniques. Matched asymptotic expansions. Prerequisite: Consent of instructor. (Lynn)

*MATH 0673-0674. Wave Propagation I, II (3, 3)
Hyperbolic equations and characteristics. System of conservation laws, finite amplitude simple waves and shocks. Dilatational and shear waves. Gravity waves. Solitary waves.

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*These courses are being considered for inclusion in the curriculum for the Academic Year 1971/72.

Non-linear dispersive waves. Geometrical optics, theory of diffraction. Waves in random media. Examples taken from fluid dynamics, elasticity, electromagnetic theory, magnetohydrodynamics and plasma dynamics. Prerequisite: Consent of instructor. (Staff)

MATH 0700. Special Topics In Algerba (Variable Credit)

MATH 0711. Special Topics In Topology (Variable Credit)

MATH 0721. Special Topics In Real Analysis (Variable Credit)

MATH 0731. Special Topics In Complex Analysis (Variable Credit)

MATH 0741. Special Topics In Numerical Analysis (Variable Credit)

MATH 0751. Special Topics In Applied Mathematics (Variable Credit)

MATH 0761. Special Topics In Mathematical Physics (Variable Credit)

MATH 0771. Special Topics In Statistics and Probability (Variable Credit)

MAHT 0799. Thesis Research (Master's Level) (Arranged)

MATH 0801. Seminar (Variable Credit)

MATH 0899. Dissertation Research (Ph.D. Level) (Arranged)

OTHER COURSES AT UMBC

In addition to its Graduate Program in Applied Mathematics UMBC offers a number of upper-level undergraduate courses (the equivalent of 100-level courses at College Park) in other fields. Students already accepted into the University of Maryland Graduate School may apply a limited number of such credits toward a graduate degree, with the approval of their academic advisor. These courses may also be taken by teachers who desire to use the credits to fulfill certification requirements.

A listing of such courses to be offered at UMBC during the Fall, 1970, semester follows. Further information about such courses and a listing of courses to be offered in subsequent semesters may be obtained from the Graduate School Office, or from the department of interest at UMBC.

American Studies 0391 American Thought
American Studies 0491 Seminar on American Character and Culture

Biological Sciences 0330 Biochemistry
Biological Sciences 1330 Biochemistry Laboratory
Biological Sciences 0620 Cell Structure and Function

Chemistry 0330 Biochemistry
Chemistry 0350 Qualitative Organic Analysis
Chemistry 0405 Theoretical Chemistry

Classics 0312 Silver Age
Classics 0352 Greek Drama

Economics 0341 American Economic History

Education 0355 Seminar in the Contemporary Philosophy of Education
Education 0390 Principles of Audiovisual Communication

English 0310 Problems in Modern Poetry
English 0331 American Literature, 1630-1850
English 0332 American Literature, 1850 to World War I
English 0344 Major Plays of Shakespeare
English 0361 Romantic Period in English Literature
English 0363 Victorian Literature I
English 0452 Chaucer

French 0415 Seventeenth Century French Literature
French 0431 Nineteenth Century French Literature
French 0471 French Civilization
French 0620 Seminar in French Literature

History 0301 History of the Old South
History 0307 Founding of the American Nation
History 0311 American Economic History
History 0321 American Civil War
History 0353 Ancient Greece
History 0372 Modern Britain, 1714-1900
History 0376 Italy Since 1860
History 0383 German History, 1500-1815
History 0385 Russian History to the 19th Century

Philosophy 0370 Philosophy of Mind
Philosophy 0455 Seminar in the Contemporary Philosophy of Education

Physics 0401 Quantum Theory I

Psychology 0310 Personality Theories
Psychology 0330 Adolescent Psychology
Psychology 0340 Educational Psychology
Psychology 0360 Psychology of Motivation
Psychology 0400 History and Systems of Psychology
Psychology 0430 Advanced Behavior Pathology
Psychology 0435 Interviewing Techniques
Psychology 0460 Seminar on Contemporary Problems in Learning
Psychology 0480 Seminar on Social Psychology

Spanish 0411 Poetry and Drama of the Golden Age
Spanish 0441 Literature of the Twentieth Century
Spanish 0471 Spanish Civilization

GRADUATE COUNCIL AND THE GRADUATE FACULTY ASSEMBLY

Ex-Officio Members

WILSON H. ELKINS, D.Phil., President of the University
R. LEE HORNBAKE, Ph.D., Vice-President for Academic Affairs
MICHAEL J. PELCZAR, JR., Ph.D., Vice-President for Graduate Studies and Research
DAVID S. SPARKS, Ph.D., Dean for Graduate Studies and Research, College Park Campus

Appointed Members

ATCHISON, William F., Ph.D., Professor of Computer Science 1971
BROOKS, Marjory, Ph.D., Dean of the College of Home Economics 1973
MANNING, Charles, Ph.D., Dean of College of Arts and Science 1972
MULLIGAN, Joseph F., Ph.D., Professor of Physics (UMBC) 1970

Elected Members

BICKLEY, William E., Ph.D., Professor of Entomology 1970
BURGISON, Raymond M., Ph.D., Professor of Pharmacology (Baltimore) 1972
DILLARD, Dudley, Ph.D., Professor of Economics 1971
DILLON, Conley H., Ph.D., Professor of Government and Politics 1973
EYLER, Marvin H., Ph.D., Professor of Physical Education 1973
KING, Raymond L., Ph.D., Professor of Dairy Science 1973
LASTER, Howard J., Ph.D., Professor of Physics and Astronomy 1973
MYERS, Ralph D., Ph.D., Professor of Physics 1970
RATHS, James, Ph.D., Professor of Education 1971
SCHLARETZKI, W. E., Ph.D., Professor of Philosophy 1972
SHAY, Donald E., Ph.D., Professor of Bacteriology and Immunology (Baltimore) 1970
SILVERMAN, Joseph, Ph.D., Professor of Chemical Engineering 1971
TAFF, Charles A., Professor of Business Administration 1972
VANDERSLICE, Joseph T., Ph.D., Professor of Chemistry 1972

THE GRADUATE SCHOOL OFFICERS AND STAFF

VICE PRESIDENT FOR GRADUATE STUDIES AND RESEARCH
Michael J. Pelczar, Jr., B.S., University of Maryland, 1936; M.S., 1938; Ph.D., State University of Iowa, 1941.

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

ASSOCIATE DEAN FOR PHYSICAL SCIENCES AND ENGINEERING
Gilbert W. Castellan, B.Sc., Regis College, 1945; Ph.D., The Catholic University of America, 1949.

ASSOCIATE DEAN FOR THE BALTIMORE CAMPUSES
John P. Lambooy, B.A., Kalamazoo College, 1937; M.S., 1938; M.A., University of Illinois, 1939; Ph.D., University of Rochester, 1942.

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

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

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

COORDINATOR OF GRADUATE SCHOOL PUBLICATIONS
Lillian W. Clark, B.A., University of Maryland, 1962.

The Faculty

AARON, Henry J., Associate Professor of Economics
B.A., University of California at Los Angeles, 1958; M.A., Harvard University, 1960; Ph.D., 1963.

ABRAMS, Marshall D., Associate Professor of Electrical Engineering
B.S., Carnegie-Mellon University, 1962; M.S., University of Pittsburgh, 1963; Ph.D., 1966.

ADAMS, Elijah, Professor and Head of Department of Biological Chemistry, School of Medicine
B.A., The Johns Hopkins University, 1938; M.D., University of Rochester, 1942.

ADAMS, John Q., Assistant Professor of Economics
B.A., Oberlin College, 1960; Ph.D., University of Texas, 1965.

ADELMAN, William J., Jr., Associate Professor of Physiology, School of Medicine
B.S., Fordham University, 1950; M.S., University of Vermont, 1952; Ph.D., University of Rochester, 1955.

ADKINS, Arthur J., Associate Professor of Education
B.S., St. Cloud Technical College, 1942; M.A., University of Minnesota, 1947; Ph.D., 1958.

AGRE, Gene P., Associate Professor of Education
B.A., Macalester College, 1951; B.S., University of Minnesota, 1953; M.A., 1956; Ph.D., University of Illinois, 1964.

A'HEARN, Michael F., Assistant Professor of Physics and Astronomy
B.S., Boston College, 1961; Ph.D., University of Wisconsin, 1966.

AHNERT, Frank Oswald, Professor of Geography
Ph.D., University of Heidelberg, 1953.

AHRENS, Richard A., Associate Professor of Food and Nutrition
B.S., University of Wisconsin, 1958; Ph.D., University of California, 1963.

ALLEN, Benjamin F., Associate Professor of Pharmacy, School of Pharmacy
B.S., University of Maryland, 1937; Ph.D., 1949.

ALLEN, Redfield W., Professor of Mechanical Engineering
B.S., University of Maryland, 1943; M.S., 1949; Ph.D., University of Minnesota, 1959.

ALLEY, Carroll O., Jr., Associate Professor of Physics and Astronomy
B.S., University of Richmond, 1948; M.A., Princeton University, 1951; Ph.D., 1962.

ALMENAS, Kazys, Assistant Professor of Chemical Engineering
B.S., University of Nebraska, 1957; Ph.D., University and Polytechnic of Warsaw, 1968.

ALMON, Clopper, Jr., Professor of Economics
A.B., Vanderbilt University, 1956; M.A., Harvard University, 1961; Ph.D., 1962.

ANAND, Davinder K., Associate Professor of Mechanical Engineering
B.M.E., The George Washington University, 1959; M.S.E., 1961; D.Sc., 1965.

ANASTOS, George, Professor of Zoology
B.S., University of Akron, 1942; M.A., Harvard University, 1947; Ph.D., 1949.

ANDERSON, Frank Gibbs, Professor of Sociology
A.B., Cornell University, 1941; Ph.D., University of New Mexico, 1951.

ANDERSON, Henry, Associate Professor of Business Administration
B.A., University of London, 1939; M.B.A., Columbia University, 1948; Ph.D., 1959.

ANDERSON, Lowell Dean, Assistant Professor of Industrial Education
B.S., St. Cloud State, 1961; M.S., 1965; Ph.D., Northern Illinois University, 1966.

ANDERSON, J. Paul, Associate Professor of Education
B.S., University of Minnesota, 1942; M.A., 1948; Ph.D., 1960.

ANDERSON, James R., Assistant Professor of Physics
B.S., Iowa State University, 1956; Ph.D., 1963.

ANDERSON, Nancy S., Professor of Psychology
B.A., University of Colorado, 1952; M.S., Ohio State University, 1953; Ph.D., 1956.

ANDERSON, Thornton H., Professor of Government and Politics
A.B., University of Kentucky, 1937; M.A., 1938; Ph.D., University of Wisconsin, 1948.

ANDERSON, Vernon E., Professor of Education
B.S., University of Minnesota, 1930; M.A., 1936; Ph.D., University of Colorado, 1942.

ANGELL, Frederick F., Assistant Professor of Horticulture
B.S., Southern Illinois University, 1960; M.S., 1961; Ph.D., University of Wisconsin, 1965.

APOSHIAN, H. Vasken, Professor and Head of Cell Biology and Pharmacology, School of Medicine
B.S., Brown University, 1948; M.S., University of Rochester, 1950; Ph.D., 1953.

ARBUCKLE, Wendell S., Professor of Dairy Science
B.S.A., Purdue University, 1933; A.M., University of Missouri, 1937; Ph.D., 1940.

ARMSTRONG, Ronald W., Professor of Mechanical Engineering
B.E.S., The Johns Hopkins University, 1955; M.Sc., Carnegie-Mellon, 1957; Ph.D., 1958.

ARSENAULT, Richard J., Associate Professor of Chemical Engineering
B.S., Michigan Technical University, 1957; Ph.D., Northwestern University, 1962.

ASHLOCK, Robert B., Associate Professor of Education
B.S., Butler University, 1957; M.S., 1959; Ed.D., Indiana University, 1965.

ASHMEN, Roy, Associate Professor of Business Administration
B.S., Drexel Institute, 1935; M.S., Columbia University, 1936; Ph.D., Northwestern University, 1950.

ASIMOW, Robert M., Associate Professor of Mechanical Engineering
B.S., University of California at Los Angeles, 1953, M.S., 1955, Ph.D., 1958.

ATCHISON, William F., Professor and Director, Computer Science Center
A.B., Georgetown College (Ky.), 1936; M.A., University of Kentucky, 1940; Ph.D., University of Illinois, 1943.

ATKINSON, Gordon, Professor of Chemistry
B.S., Lehigh University, 1952; Ph.D., Iowa State College, 1956.

AUSLANDER, Joseph, Professor of Mathematics
B.S., Massachusetts Institute of Technology, 1952; M.S., University of Pennsylvania, 1953, Ph.D., 1957.

AUSTING, Richard H., Assistant Professor of Computer Science
B.S., Xavier Institute, 1953; M.S., St. Louis University, 1955; Ph.D., Catholic University, 1963.

AVERY, William T., Professor and Head of Classical Languages and Literatures
B.A., Western Reserve University, 1934; M.A., 1935; Ph.D., 1937.

AXLEY, John H., Professor of Agronomy
B.A., University of Wisconsin, 1937; Ph.D., 1945.

AYCOCK, Marvin K. Jr., Assistant Professor of Agronomy
B.S., North Carolina State University, 1959; M.S., 1963; Ph.D., Iowa State University, 1966.

AZIZ, Abdul Kadir, Professor of Mathematics
B.S., Wilson Teachers College, 1952; M.S., George Washington University, 1954; Ph.D., University of Maryland, 1958.

BAILEY, William J., Research Professor of Chemistry
B. Chem., University of Minnesota, 1943; Ph.D., University of Illinois, 1946.

BAKER, Donald J., Assistant Professor of Speech
B.S.Ed., The Ohio State University, 1954; M.A., 1956; Ph.D., 1962.

BANDEL, V.A., Associate Professor of Agronomy
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BANERJEE, Manoj K., Professor of Physics and Astronomy
B.Sc., Patna University, 1949; M.Sc., Calcutta University, 1951; Ph.D., 1956.

BARBER, Willard F., Lecturer in Government and Politics
A.B., Stanford University, 1928; M.A., 1929; Diploma, The War College ,1948.

BARDASIS, Angelo, Associate Professor of Physics and Astronomy
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BARRACLOUGH, Charles A., Associate Professor of Physiology, School of Medicine
B.S., St. Joseph's College, 1947; M.S., Rutgers University, 1952; Ph.D., 1953.

BARRY, Sue-ning Chu, Assistant Professor of Histology and Embryology, School of Dentistry
B.A., Barat College, 1955; Ph.D., University of Maryland, 1961.

BARTLETT, Claude Jackson, Associate Professor and Head of Department of Psychology
B.S., Dension University, 1954; M.A., Ohio State University, 1956; Ph.D., 1958.

BASHAM, Ray Scott, Associate Professor of Electrical Engineering
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BAUER. Richard H., Professor Emeritus of History
Ph.B., University of Chicago, 1923; M.A., 1928; Ph.D., 1935.

BEAGLEHOLE, David, Associate Professor of Physics and Astronomy
B.Sc., Victoria University of Wellington, 1959; M.Sc., 1960; Ph.D., Cambridge University, England, 1964.

BEAL, George M., Professor of Agricultural Economics and Marketing
B.S., Utah State Agricultural College, 1934; M.S., University of Wisconsin, 1938; Ph.D., 1942.

BEALL, Edgar F., Associate Professor of Physics and Astronomy
B.A., University of California, 1958; Ph.D., 1962.

BEALL, Otho Thompson, Jr., Professor and Director of American Studies Program
B.A., Williams College. 1930; M.A., University of Minnesota, 1932; Ph.D., University of Pennsylvania, 1952.

BEAN, George A., Assistant Professor of Botany
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BEATTY, Charles Joseph, Associate Professor of Industrial Education
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BECHTOLD, Peter K., Assistant Professor of Government and Politics
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BECKERMAN, Tod, Assistant Professor of Pathology, School of Dentistry
B.A., Emory University, 1959; D.D.S., Columbia University, 1963.

BECKMANN, Robert Bader, Professor and Dean, College of Engineering
B.S., University of Illinois, 1940; Ph.D., University of Wisconsin, 1944.

BELCHER, Ralph, L., Lecturer in Chemical Engineering
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BELL, Roger A., Assistant Professor of Physics
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BELZ, Herman J., Associate Professor of History
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BENDER, Filmore E., Assistant Professor of Agricultural Economics
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BENEDETTO, John J., Associate Professor of Mathematics
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BENEDICT, William S., Professor, Institute for Molecular Physics
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BENESCH, William, Professor, Institute for Molecular Physics
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BENNETT, Lawrence H., Lecturer in Physics and Astronomy
B.A., Brooklyn College, 1951; M.S., University of Maryland, 1955; Ph.D., Rutgers University, 1958.

BENNETT, Robert L., Associate Professor of Economics
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BERG, Richard E., Assistant Professor of Physics and Astronomy
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BERGMANN, Barbara R., Associate Professor of Economics
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BERMAN, Louise M., Professor of Education
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BERNSTEIN, Melvin, Professor of Music
A.B., Southwestern, 1947; B. Music, 1948; M. Music, University of Michigan, 1949; M.A., University of North Carolina, 1954; Ph.D., 1963.

BEST, Otto F., Associate Professor of German
Abitur, Realgymnasium, 1948; Certificate, University de Toulouse, 1951; Doctor of Philosophy, University of Munchen, 1963.

BETTINGER, Richard T., Assistant Professor of Physics and Astronomy
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BEVERIDGE, Charles Eliot, Assistant Professor of History
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BHAGAT, S. M., Associate Professor of Physics and Astronomy
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BHATIA, Nam Parshad, Professor of Mathematics (U.M.B.C.)
M.S., Agra University, 1954; M.S., 1956; Dr. rer., nat., Technische Hochschule, 1961.

BICKLEY, William E., Professor and Head of Department of Entomology
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BIGBEE, Dan E., Associate Professor of Poultry Science
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BILLIG, Frederick S., Lecturer in Aerospace Engineering, Project Supervisor, Hypersonic Propulsion
B.E., The Johns Hopkins University, 1955; M.S., University of Maryland, 1958; Ph.D., 1964.

BINGHAM, Alfred Jepson, Professor of French and Italian Language and Literature
B.A., Yale University, 1933; Ph.D., Columbia University, 1939.

BIRKNER, Francis B., Associate Professor of Civil Engineering
B.S.C.E., Newark College of Engineering, 1961; M.S.E., University of Florida, 1962; Ph.D., 1965.

BLAKE, David A., Associate Professor and Chairman of Pharmacology, School of Pharmacy
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BLAKE, William Dewey, Professor and Head of Department of Physiology, School of Medicine
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BLOMSTER, Ralph N., Professor and Head of Pharmacognosy, School of Pharmacy
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BLOUGH, Glenn O., Professor of Education
A.B., University of Michigan, 1929; A.M., 1932; LL.D., Central Michigan College of Education, 1950.

BODE, Carl, Professor of English
Ph.B., University of Chicago, 1933; M.A., Northwestern University, 1938; Ph.D., 1941.

BOLEA, Angelo Samuel, Associate Professor, Institute for Child Study
B.A., Drury-Evangel College, 1960; Ed. M., Wayne State University, 1963; Ph.D., University of Maine, 1966.

BOLSAITIS, Pedro, Associate Professor of Chemical Engineering
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BOWIE, Blanche Lucile, Professor of Education
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BOYD, Alfred C., Jr., Associate Professor of Chemistry
B.S., Canisius College, 1951; M.S., Purdue University, 1953; Ph.D., 1957.

BRACE, John W., Professor of Mathematics
B.A., Swarthmore College, 1949; A.M., Cornell University, 1951; Ph.D., 1953.

BRADBURY, Miles L., Assistant Professor of History
A.B., Harvord, 1960; A.M., 1961; Ph.D., 1967.

BRANDT, Richard A., Assistant Professor of Physics and Astronomy
S.B., M.I.T., 1963; Ph.D., 1966.

BRANN, Noel L., Assistant Professor of History
A.B., Antioch College, 1960; Ph.D., Stanford University, 1965.

BRESLOW, Marvin A., Associate Professor of History
B.A., University of Nebraska, 1957; M.A., Harvard University, 1958; Ph.D., 1963.

BRICKER, A. June, Extension Professor and Head of Department, Extension Home Economics
B.S., Battle Creek College, 1935; M.A., New York University, 1953; Ph.D., 1961.

BRIGHAM, Bruce W., Associate Professor of Education
B.S., State University of New York, 1949; M.S., Ph.D., Temple University, 1967.

BRINKLEY, Howard J., Associate Professor of Zoology
B.S., West Virginia University, 1958; M.S., University of Illinois, 1960; Ph.D., 1963.

BRODSKY, Harold, Assistant Professor of Geography
B.S., Brooklyn College, 1954; M.S., University of Colorado, 1960; Ph.D., University of Washington, 1966.

BROOKS, Marjory, Professor and Dean of College of Home Economics
B.S., Mississippi State College, 1943; M.S., University of Idaho, 1951; Ph.D., Ohio State University, 1963.

BROWN, Irving Marsan, Professor and Director of Fine Arts Program, Humanities Division, U.M.B.C.
B.A., Antioch College, 1948; M.A., University of Iowa, 1950; Ph.D., Ohio State University, 1961.

BROWN, John H., Associate Professor of Philosophy
A.B., Princeton University, 1952; M.A., 1957; Ph.D., 1959.

BROWN, Joshua R. C., Associate Professor of Zoology
A.B., Duke University, 1948; M.A., 1949; Ph.D., 1953.

BROWN, Russell G., Associate Professor of Botany
B.S., Agr., West Virginia University, 1929; M.S., 1930; Ph.D., University of Maryland, 1934.

BROWN, Samuel E., Associate Professor of English
A.B., Indiana University, 1934; M.A., 1946; Ph.D., Yale University, 1955.

BROWN, William David, Chairman and Associate Professor of Family and Community Development (Home Economics)
B.A., Lynchburg College, 1959; B.D., Texas Christian University, 1962; Th.M., 1962; Ph.D., Florida State University, 1965.

BRUSH, Stephen George, Associate Professor of History
B.A., Harvard University, 1955; D. Phil., Oxford, 1958.

BRYER, Jackson R., Assistant Professor of English
B.A., Amherst College, 1959; M.A., Columbia University, 1960; Ph.D., University of Wisconsin, 1965.

BUCCI, Enrico, Associate Professor of Biochemistry, School of Medicine
M.D., University of Rome, 1956; Ph.D., 1963; Ph.D., 1965.

BUNDY, Mary Lee, Professor, School of Library and Information Services
B.E., State University of New York, 1948; M.A., University of Denver, 1951; Ph.D., University of Illinois, 1960.

BURCH, Buckner S., Assistant Professor of Pathology, School of Dentistry
B.S., University of Southern California, 1955; D.D.S., St. Louis University, 1959; M.S., University of Oregon, 1965.

BURDETTE, Franklin L., Professor of Government and Politics and Director of the Bureau of Governmental Research
A.B., Marshall College, 1934; A.M., University of Nebraska, 1935; A.M., Princeton University, 1937; Ph.D., 1938; LL.D., Marshall College, 1959.

BURGERS, Johannes Martanus, Research Professor, Institute for Fluid Dynamics and Applied Mathematics
Doctor of Mathematics and Physics, University of Leiden, 1918; Doctor Honoris Causa, Université Libre de Bruxelles, 1948; Doctor Honoris Causa, Université de Poiters, 1950; Doctor of Science in Technology, The Technion, 1955.

BURGISON, Raymond M., Professor and Head of Department of Pharmacology, School of Dentistry
B.S., Loyola College, 1945; M.S., University of Maryland, 1948; Ph.D., 1950.

BURT, Gordon W., Assistant Professor of Agronomy
B.S., Tennessee Technological University, 1961; M.S., Cornell University, 1964; Ph.D., Washington State University, 1967.

BUTLER, Lillian C., Associate Professor of Food and Nutrition
B.S., University of Illinois, 1941; M.S., University of Texas, 1945; Ph.D., University of California, 1953.

BUTTRICK, Shirley M., Associate Professor, School of Social Work and Community Planning
B.A., Brooklyn College, 1945; M.A., University of Michigan, 1946; M.A., University of Chicago, 1951; D.S.W., Catholic University, 1969.

BYRD, Elbert M., Jr., Associate Professor of Government and Politics
B.S., The American University, 1953; M.A., 1954; Ph.D., 1959.

BYRNE, Richard H., Professor of Education
A.B., Franklin and Marshall College, 1938; M.A., Columbia University, 1947; Ed.D., 1952.

CADMAN, Theodore W., Associate Professor of Chemical Engineering
B.S., Carnegie Institute of Technology, 1962; M.S., 1964; Ph.D., 1966.

CAIN, Jarvis Lynn, Associate Professor of Agricultural Economics
B.S., Purdue University, 1955; M.S., Ohio State University, 1956; Ph.D., 1961.

CAIRNS, Gordon M., Professor of Dairy Science and Dean of College of Agriculture
B.S., Cornell University, 1936; M.S., 1938; Ph.D., 1940.

CALLCOTT, George H.. Professor of History and Acting Vice Chancellor for Academic Affairs
A.B., University of South Carolina, 1950; M.A., Columbia University, 1951; Ph.D., University of North Carolina, 1956.

CAMPBELL, Elwood G., Associate Professor of Secondary Education
B.S., Northeast Missouri State College, 1949; M.A., Northwestern University, 1952; Ph.D., 1963.

CARR, John C., Associate Professor of Secondary Education
B.S., Wilson Teachers College, 1952; M.F.A., Catholic University, 1953; Ph.D., 1965.

CARROLL, Robert M., Assistant Professor of Psychology
B.S., University of New Mexico, 1965; M.A., Ohio State University, 1968; Ph.D., 1969.

CARROLL, Stephen J., Jr., Professor of Business Administration
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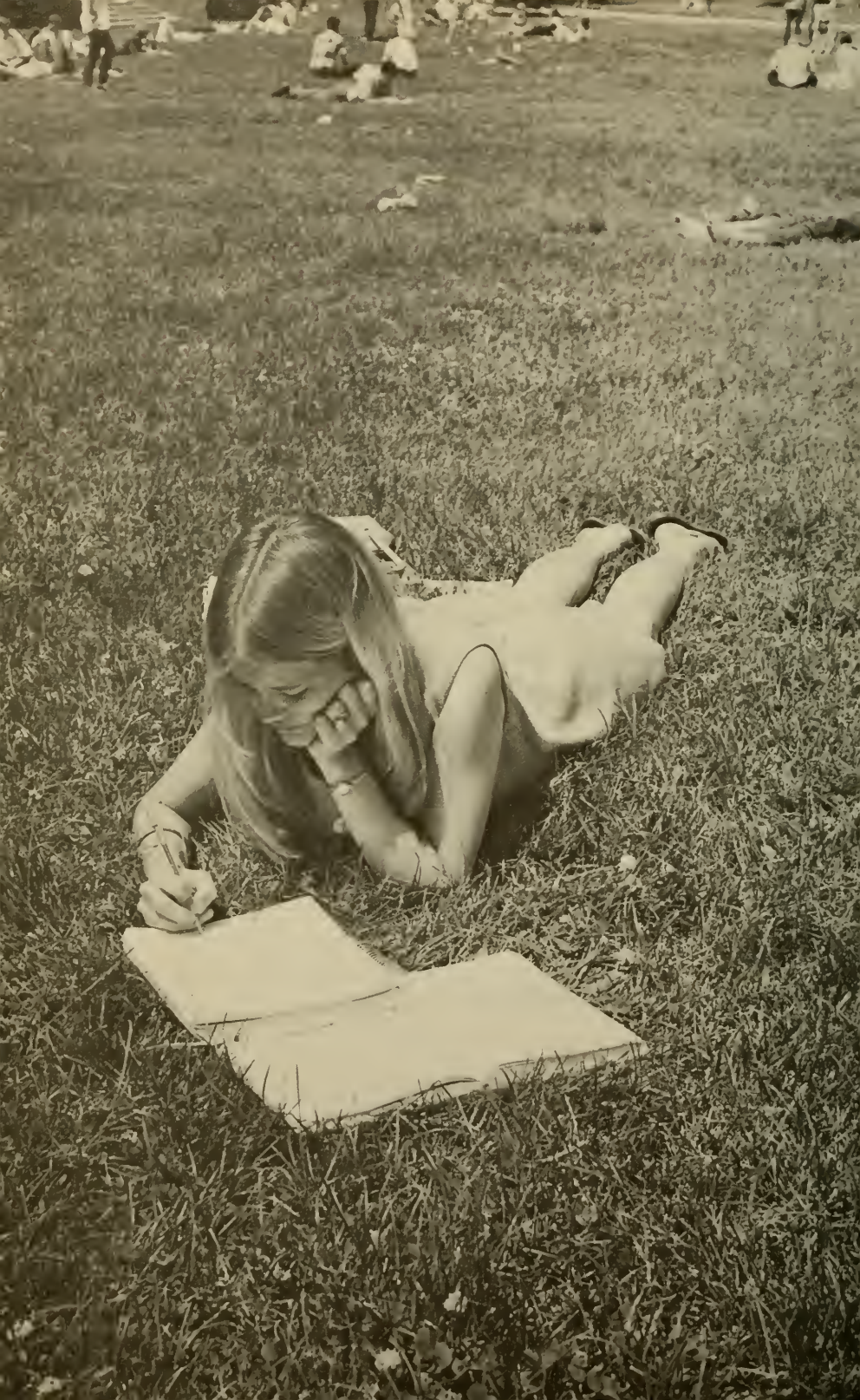

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10. GEORGE WASHINGTON UNIVERSITY
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22. THE ARENA STAGE
23. THE ISLAMIC CENTER

"The purpose of a university is to perform at a high level in all of its endeavors and to elevate the individual and society. It should remain a place where new ideas can be expounded and nurtured. It should lead in the discovery of the truth and in the orderly discussion of controversial issues. Just as it teaches tolerance, it should tolerate lawful dissent and expect restlessness and impatience. The University, however, should not be an activist organization. Rather its proper role is to examine the issues, thereby enabling individuals to arrive at conclusions and to act or not to act as they believe is right. A public university cannot be independent of government but its governing board should be autonomous, and it should resist with all its will and rising influence any effort toward political control. A university must be free in the proper sense of freedom."

From "Issues and Rumblings in Higher Education"—
Convocation Address of President
Dr. Wilson H. Elkins
April 19, 1967
College Park Campus, Maryland

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