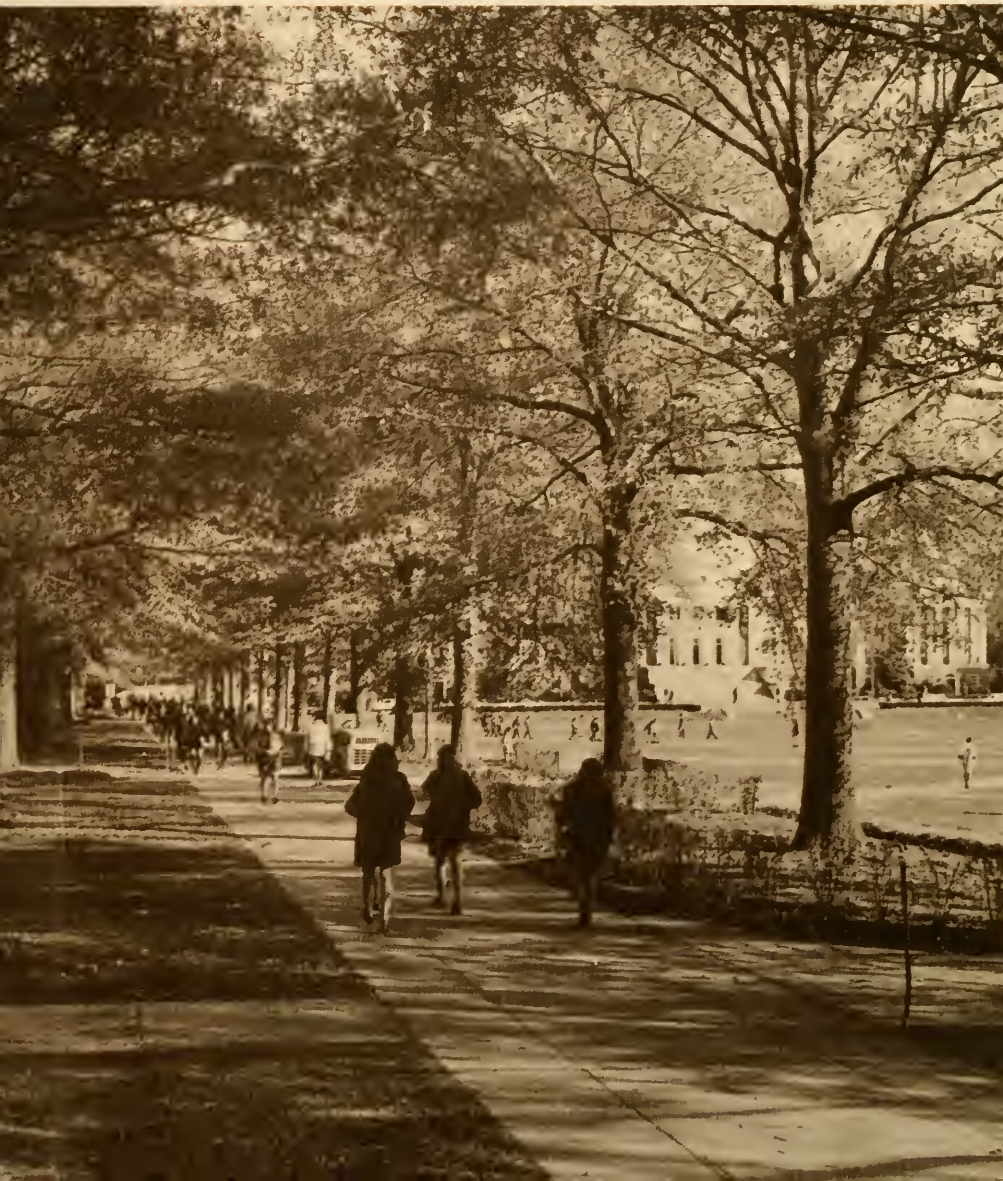
GRADUATE SCHOOL

1968–1970

UNIVERSITY OF MARYLAND BULLETIN



The provisions of this publication are not to be regarded as an irrevocable contract between the student and the University of Maryland. The University reserves the right to change any provision or requirement at any time within the student's term of residence. The University further reserves the right, at any time, to ask a student to withdraw when it considers such action to be in the best interests of the University.

CATALOG

GRADUATE SCHOOL

1968-1970

UNIVERSITY OF MARYLAND

Volume 25 *September 5, 1968* *No. 8*

UNIVERSITY OF MARYLAND BULLETIN is published six times in August; five times in September; four times in October and June; one time in November, February, and May; two times in December, March, and July; and three times in January, and April. Published 34 times. Re-entered as second class mail matter under the Act of Congress on August 24, 1912, and second class postage paid at College Park, Maryland 20742.

Contents

PROGRAMS AND COURSES

University Calendar, 1968-1969

FALL SEMESTER, 1968

SEPTEMBER	9-13	Monday-Friday	Fall Registration
	16	Monday	Instruction begins
NOVEMBER	27	Wednesday	After last class—Thanksgiving recess begins
DECEMBER	2	Monday	8:00 a.m.—Thanksgiving recess ends
	20	Friday	After last class—Christmas recess begins

1969

JANUARY	6	Monday	8:00 a.m. Christmas recess ends
	14	Tuesday	After last class—end of instruction
	16-24	Thursday-Friday	Fall Semester Examinations

SPRING SEMESTER, 1969

FEBRUARY	3-7	Monday-Friday	Spring Registration
	10	Monday	Instruction begins
	22	Saturday	Washington's Birthday, holiday—No classes
MARCH	28	Friday	After last class—Spring recess begins
APRIL	8	Tuesday	8:00 a.m.—Spring recess ends
MAY	27	Tuesday	After last class—end of instruction
	29-June 6	Thursday-Friday	Spring Semester Examinations
	30	Friday	Memorial Day, holiday—No examinations
JUNE	7	Saturday	Commencement

SUMMER SCHOOL, 1969

JUNE	23-24	Monday-Tuesday	Summer Registration
	25	Wednesday	Instruction begins
JULY	4	Friday	Independence Day, holiday—No classes
AUGUST	15	Friday	Summer Session ends

SHORT COURSES, 1969

JUNE	16-20	Monday-Friday	College Week for Women
AUGUST	4-8	Monday-Friday	Maryland 4-H Club Week
SEPTEMBER	2-5	Tuesday-Friday	Fireman's Short Course

1969-1970

FALL SEMESTER, 1969

SEPTEMBER	8-12	Monday-Friday	Fall Semester Registration
	13	Saturday	Teacher Registration
	15	Monday	Instruction begins
NOVEMBER	26	Wednesday	After last class—Thanksgiving recess begins
DECEMBER	1	Monday	Thanksgiving recess ends
	19	Friday	After last class—Christmas recess begins

1970

JANUARY	5	Monday	Christmas recess ends
	14	Wednesday	Pre-exam Study Day
	15-22	Thursday-Thursday	Fall Semester examinations

SPRING SEMESTER, 1970

FEBRUARY	2-6	Monday-Friday	Spring Semester Registration
	7	Saturday	Teacher Registration
	9	Monday	Instruction begins
MARCH	26	Thursday	After last class—Spring recess begins
APRIL	6	Monday	8:00 a.m.—Spring recess ends
MAY	27	Wednesday	Pre-exam Study Day
	28-June 5	Thursday-Friday	Spring Semester Examinations
JUNE	1	Monday	Memorial Day
	6	Saturday	Commencement

SUMMER SESSION, 1970

JUNE	22-23	Monday-Tuesday	Summer Registration
JUNE	24	Wednesday	Instruction begins
AUGUST	14	Friday	Summer Session ends

SHORT COURSES, 1970

JUNE	15-18	Monday-Thursday	College Week for Women
AUGUST	3-7	Monday-Friday	Maryland 4-H Club Week
SEPTEMBER	8-11	Tuesday-Friday	Fireman's Short Course

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THE FUTURE OF THE UNIVERSITY

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STANDING, FROM LEFT TO RIGHT

Howard J. Laster, Joseph T. Vanderslice, V. R. Cardozier, James D. Raths, William F. Atchison, Charles A. Taff.

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MITCHELL, T. Faye, M.A., Professor of Home Economics 1969
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EXCERPTS
FROM THE CATALOG OF THE GRADUATE SCHOOL, 1968-1970

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. Prior to the present organization some advanced degrees were awarded but they were under the jurisdiction of the individual departments subject to the supervision of the general faculty.

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 sixty graduate programs are authorized leading to one or more of the advanced degrees awarded by the University.

The Graduate School establishes minimum regulations and requirements, both for admission and for degree programs, that must be fulfilled by all students. Many departments or divisions impose additional requirements.

The Graduate Council consists of ex-officio, elected and appointed members of the Graduate Faculty and is charged with the formulation of the overall policies of The Graduate School. It meets regularly to consider all matters relating to graduate work brought to its attention by the University Administration, members of the Graduate Faculty, graduate students, or the Vice President for Graduate Studies and Research. It may also be called for special meetings throughout the year if urgent business must be transacted.

The following standing committees are appointed by the Vice President for Graduate Studies and Research:

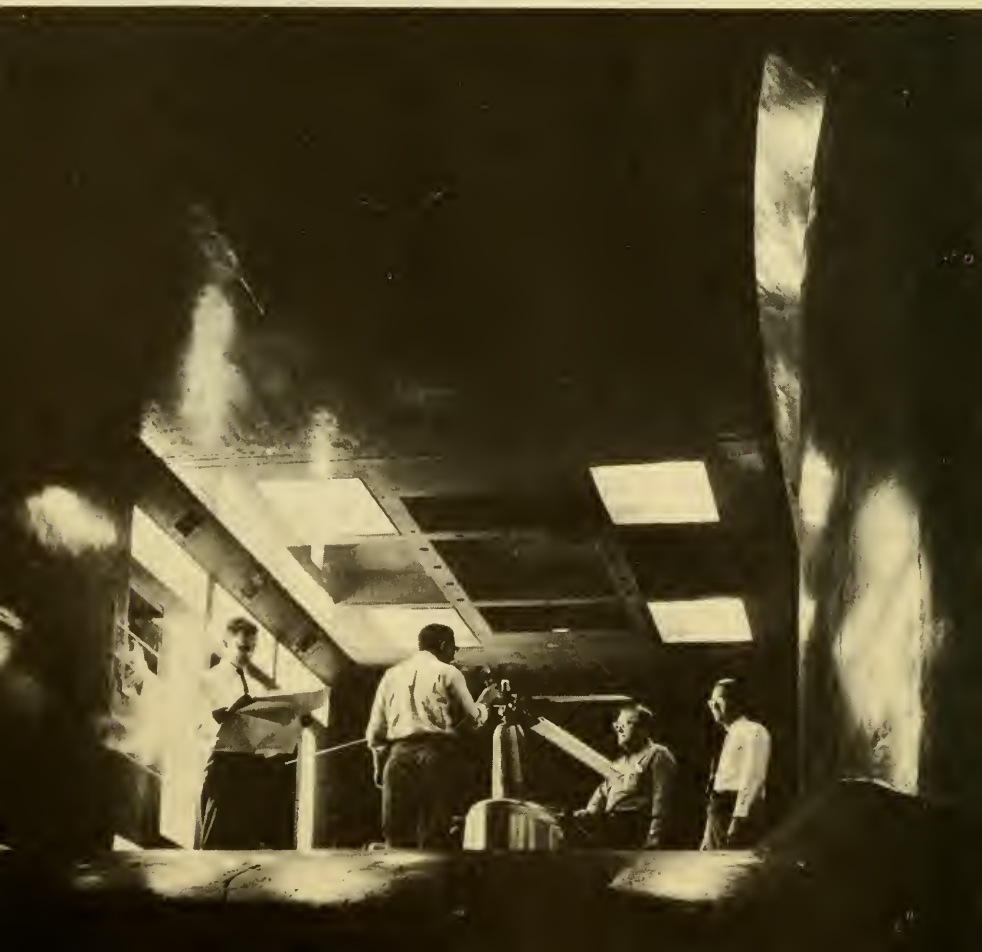
Committee on Academic Standards
Committee on Elections and Procedures
Committee on Fellowships
Committee on Graduate Faculty
Committee on Language Requirements
Committee on Programs and Courses
Committee on Publications
Committee on Research
Committee on Student Welfare

Graduate students join Graduate Faculty members in representation on seven of the nine committees. They report annually to the Graduate Council and more frequent reports may be requested by the Vice President for Graduate Studies and Research or by the Graduate Faculty Assembly.

The Graduate Faculty, now numbering nearly 900 members, is comprised of regular and associate members chosen in accordance with the Plan of Organization of the Graduate Faculty. The direction of individual programs and theses is primarily assigned to the regular members of the Graduate Faculty.

The Graduate Faculty Assembly consists of the regular and associate members of the Graduate Faculty and meets at least once each year. Special meetings may be called by the Vice President for Graduate Studies and Research if necessary. In accordance with the University Faculty Organization Plan, it has authority over the educational policy of The Graduate School, may review actions taken by the Graduate Council, and serves as a referendum body on questions referred to it by the Graduate Council.

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 does not discriminate on the grounds of race, sex, color, national origin, or religious faith.

Enrollment

Over 8,000 graduate students were enrolled during the Fall 1968 semester. Over half of these were full-time students. The student body included students from virtually every state in the Union and fifty-eight foreign nations. During the 1967-68 academic year, 241 doctorates and 930 masters 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 thirty-two miles from Baltimore.

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 newly created Baltimore County Campus of the University of Maryland is located adjacent to the exit of the Baltimore Beltway at Catonsville. Opportunities for graduate study at this location are presently being developed and will be expanded in the years to come.

All three 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 are nearing the one million mark and growing rapidly.

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

The resources of the University library system are supplemented by the immense library resources of the Washington-Baltimore area. In addition to more than five hundred specialized libraries in the area, there are the unex-

celled collections of the Library of Congress, the Folger Library, the National Archives, the National Library of Medicine, and the new National Agricultural Library, located just three miles from the College Park campus and scheduled to open in 1969. In Baltimore, the resources of the University libraries are supplemented by the Enoch Pratt Free Library and other resources.

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, Maryland.

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 is being developed on the Baltimore campus.

Exceptional research facilities in the physical sciences include a 160 Me V cyclotron; two small Van de Graaff accelerators; an assortment of computers, including an IBM 7094, two 1401's, and a Univac 1108 to be complemented with 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.*

Admission—General

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. They have been established on the basis of long experi-

ence with those who have succeeded, as well as with those who have failed, in graduate study. They are very 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.

The basic minimum standard for admission to The Gradute School is a "B" average, or 3.0 on a 4.0 scale, as an undergraduate student in 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.

Admission to graduate study at the University of Maryland is the exclusive responsibility of The Gradute School and the Vice President for Graduate Studies and Research. In making decisions upon the admissibility of many applicants, the Vice President and his staff regulary 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.

In the interest of providing those who review the qualifications of each applicant with the best possible information on which to base their recommendations, all applicants are urged to submit, in addition to the required transcripts of all previous study, test scores from the appropriate Graduate Record Examination, or other advanced aptitude tests. When requested, letters of recommendation from those qualified to judge the applicant should be sent directly to the department to which the applicant expects to be admitted.

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 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 when 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.

Students are admitted to The Graduate School in one of the following categories and are notified of their classification at the time they are offered admission.

Full Graduate Status

This designation is assigned when the applicant is fully qualified in every respect and he may begin his advanced degree program immediately.

Provisional Graduate Status

This designation may be used when (1) the previous academic record is on the borderline or when there is a lack of adequate prerequisite course work in the chosen field; or (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. 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 take courses 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. Another example would be the student in Education with an M.A. or M.Ed. who wants to work toward the Advanced Graduate Specialist Certificate instead of the doctorate. Also included under the non-degree designation is the transfer student who is in good standing as a graduate student at another institution. (See also Transfer Student Application.)

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.

Non-Degree Graduate Status-Institute Only: This designation is assigned to applicants not qualified for regular admission, but to whom the Institute may wish to present an award or fellowship or to those qualified applicants who do not desire regular admission.

Special Undergraduate Student Status

This is an undergraduate classification and it may be assigned by the Director, Admissions and Registration (Undergraduate Division), to those applicants who have received the baccalaureate degree from an accredited institution, but who do not desire or qualify for graduate admission.

Some 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.

ADMISSION AND REGISTRATION

Application for Admission

Initial correspondence concerning application for admission to the Graduate School should be addressed to *The Graduate School, University of Maryland, College Park, Maryland 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.*

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. 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.

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 course work and the awarding of the degree. Applicants engaged in graduate study at another institution are also subject to this policy. A student faces cancellation of his course registration if a complete record of all previous work is not received within three months following the completion of such study.

An 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 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.

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, are retained for one year only.

Transfer Student Application

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-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 Application

Academic Qualifications. 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—must be received by the Graduate Admission Office at least six months prior to the semester for which he plans to begin his studies. 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.

English Proficiency. In addition to meeting academic requirements, the foreign student application must demonstrate his proficiency in English by taking TOEFL (The Test of English as a Foreign Language) where available. 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, New Jersey 08540, to take the test as soon as he contemplates study at the University of Maryland. Where TOEFL is not available, notify the Director of International Education Services and Foreign Student Affairs, University of Maryland, who will send instructions about arranging for a standard English proficiency test to be administered by the nearest American Consulate or Embassy. The Embassy

or Consulate will also have information about any orientation programs that may be available in your country. Thus, 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.

Finances. A statement regarding the applicant's financial status is required by the Office of International Education Services and Foreign Student Affairs. Approximately $250.00 a month, or $3,000.00 a year, is required for educational and living expenses of two academic semesters and a summer session. A few 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.

Immigration Documents. 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.

Special Services for Foreign Students. 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, Maryland 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 Institute Training

During the summer session and during the regular academic year, special training programs are offered for the benefit of teachers and other groups with specialized objectives. These programs, frequently referred to as institutes, may be attended by admitted graduate degree-seeking students. Applicants not working toward a graduate degree or those who do not qualify for regular admission may also be admitted on an Institute Only basis. Participation in these institutes is not limited to admitted graduate students. However, if the institute applicant expects to apply the credit earned in an institute toward a regular graduate degree program, he should apply for admission to full graduate status.

Individuals classified as Special Students may also qualify for these special programs.

Applications for admission should be sent directly to the Director of the Institute or Program, who will file with the Director of Graduate Records well in advance, a statement of the nature of the program, a copy of the contract, the criteria and methods used in selection of the students, and the assurance that each student recommended for admission to a graduate institute status has completed adequate preparation for the course.

Admission in a Non-Degree Graduate Status-Institute Only classification carries with it no implication that the student will later be considered for admission in any other classification.

The Non-Degree Graduate Status-Institute Only admitted classification terminates upon completion of the institute or program in which the student was enrolled. A new application must be made for subsequent programs of a similar nature.

Registration

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 becomes valid when he registers for and completes at least one course during the semester for which *he was admitted.*

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, Maryland 20742.

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

Auditors. A student who desires to attend a course without performing the work of the course *must first secure the consent of the instructor.* He must register as an auditor and pay regular fees. No credit will be granted for the course.

Continuous Registration

Following advancement to candidacy by the Graduate Council, the graduate student must register every semester exclusive of the summer sessions or obtain official leave of absence from The Graduate School until the degree is awarded. Failure to comply with this requirement will be considered as evidence of the student's termination of his graduate program.

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, Maryland 20742.

Graduate Work in Professional Schools at Baltimore

Graduate courses and opportunities for research are offered in the professional schools at 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.

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; and The Inter-University Communications Council. 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 off-campus locations. For information concerning these offerings, contact The Graduate School, or the Dean, University College, University of Maryland, College Park, Maryland 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 fifteen 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 apply to The Graduate School about procedure.

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

THESIS OPTION

Course Requirements. A minimum of twenty-four 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 thirty. 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 twenty-four hours required in graduate courses, not less than twelve and not more than sixteen 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 time period.

Transfer of Credit. Credit not to exceed six semester hours for course work at other recognized institutions may be applied toward the masters 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 twelve 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 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 other members of the committee are persons under whom the student has taken most of his major and minor courses. 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 ample opportunity 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.

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 thirty semester credit hours in courses approved for graduate credit with a minimum average grade of "B"; a minimum of eighteen semester credit hours in courses numbered two hundred 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 masters 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 Arts in American Studies

A student seeking a Master of Arts degree in American Studies must complete a minimum of thirty semester hours if in the non-thesis program; or twenty-four semester hours plus six hours of master's level thesis research in the thesis program. The thesis is required of any student seeking information to the doctoral program in American Studies. Four courses are required in either case: American Studies 200, 201, 202, and either English 201 (Bibliography and Methods) or History 300 (Historiography). The remainder of the program is normally chosen from the offerings of the Departments of Art, English, History, and Philosophy. The student is also required to pass a written and oral comprehensive examination under both the thesis and the non-thesis programs.

All other requirements are the same as for the degree of Master of Arts and Master of Science in other fields.

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 thesis. For requirements for the degree see Statement of Policies and Procedures, 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 its relationship with government.

Beyond the core, further advanced work may be taken in Management and in Statistics, and in 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, New Jersey. 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 in the day school and is conducted on the campus.

Course Requirements. Course requirements for the Degree of Master of Business Administration are: a minimum of thirty 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 thirty hours required in graduate courses, not less than six and not more than nine 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

Four areas of specialization are provided 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. Specialization 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. Specialization 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. Specialization in composition leads to the development of creative ability. A thesis consisting of an original composition of major proportions will be required.

4. Specialization 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-level recital containing the works covered in the paper.

At least nine semester hours of the thirty required for the degree will normally be in a field of music outside the area of specialization (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, Maryland 20742.

Requirements for the Degree of Master of Social Work

The School of Social Work offers work leading to the degree of Master of Social Work with concentrations in social casework and community planning.

Concurrent field instruction is provided in cooperative arrangements with affiliated social agencies throughout Maryland.

Two academic years of full-time study are required for completion of the School's requirements. 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 Program

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. Before admission to candidacy, the applicant must have demonstrated to the satisfaction of the Graduate Council that he possesses a working knowledge of two foreign languages or a high level of knowledge of one foreign language. The languages are to be chosen from a list approved by the student's major department and the Graduate Council. In some departments, an additional research method or procedure may be substituted for a second foreign language. Because there are differences among the options selected by the various departments, each student applicant for candidacy must determine in advance the options available to him for satisfying the foreign language requirements.

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 also required 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.

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.

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 Ph.D. degree must, however, register for a minimum of twelve semester hours of doctoral research, numbered 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 held before a committee appointed by the Vice President. One member of this committee is a representative of the Graduate Faculty who is not directly concerned with the student's graduate work. One or more members of the committee may be persons from other institutions who are distinguished scholars in the student's major field.

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 Ph.D. 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, Maryland 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

candidacy. 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 a full-length recital, and the successful completion of the doctoral foreign language requirement are prerequisites for admission to candidacy. After admission to candidacy the student must complete his thesis and perform a final recital.

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 Doctorate in Business Administration degree *one academic year before the degree is 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

DEPARTMENTS AND PROGRAMS OFFERED ON THE COLLEGE PARK CAMPUS	DEGREES OFFERED
Aerospace Engineering	M.S., Ph.D.
Agricultural Economics	M.S., Ph.D.
Agricultural Extension Education	M.S., A.G.S., Ph.D.
Agricultural Engineering	M.S.
Agronomy	M.S., Ph.D.
American Studies	M.A., Ph.D.
Animal Science	M.S., Ph.D.
Art	M.A., Ph.D.
Astronomy (see Physics)	
Botany	M.S., Ph.D.
Business Administration	M.B.A., D.B.A.
Chemical Engineering	M.S., Ph.D.
Chemical Physics	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.
Dairy Science	M.S., Ph.D.
Economics	M.A., Ph.D.
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.S., 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.S., Ph.D.
Home Economics	M.S.
Horticulture	M.S., Ph.D.
Institute for Fluid Dynamics and Applied Mathematics	M.S., Ph.D.
School of Library and Information Services	M.L.S.
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	M.A., Ed.D., 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, MARYLAND

	Degrees Offered
DENTISTRY, SCHOOL OF	
Anatomy	M.S., Ph.D.
Biochemistry	M.S., Ph.D.
Histology and Embryology	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Oral Surgery	M.S.
Pathology	M.S., Ph.D.
Physiology	M.S., Ph.D.
MEDICINE, SCHOOL OF	
Anatomy	M.S., Ph.D.
Biological Chemistry	M.S., Ph.D.
Biophysics	M.S., Ph.D.
Legal Toxicology and Medicine	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Pharmacology	M.S., Ph.D.
Physiology	M.S., Ph.D.
PHARMACY, SCHOOL OF	
Pharmacy	M.S., Ph.D.
Pharmaceutical Pharmacognosy	M.S., Ph.D.
Microbiology	M.S., Ph.D.
Physiology	M.S., Ph.D.
Chemistry	M.S., Ph.D.
Pharmacology	M.S., Ph.D.
NURSING, SCHOOL OF	
Nursing	M.S.
SOCIAL WORK, SCHOOL OF	
Social Work	M.S.W.

Further 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, Maryland 20742

2. *For departments located in Baltimore:*

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

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.

The residence status of a wife follows that of her husband, except that no woman originally enrolled as a single student and continuously enrolled in the University shall gain or lose residence status solely by virtue of marriage.

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.

An adult student may request that his non-residence designation be changed by presenting proof of ownership and occupancy of his home in the state for six consecutive months, or by presenting a notarized statement that he has been employed for a period of six consecutive months on a full-time basis and not enrolled full-time (9 semester hours of credit) in any school or college.

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.

Living Accommodations

There is ample off-campus housing, ranging from single rooms to three-bedroom apartments at prices from $40 to $180 per month. University apartments are available, in limited quantities, to married teaching assistants. Food prices are similar to those in metropolitan centers throughout the nation.

Financial Aid

Fellowships. The *Maryland Fellowship Program*, established by the State Legislature and administered by The Graduate School, makes a number of fellowships available to qualified applicants who also 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 all fees remitted.

Another type of financial aid in this category is the *Graduate Fellowship* awarded on a competitive basis by The Graduate School, which carries a stipend on a nine-month basis of $1000 and remission of all fees except the graduation fee.

Summer Dissertation Fellowships are also 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, the National Institutes of Health, the National Aeronautics and Space Administration, 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 in order to be eligible.

Assistantships. There are, in addition, teaching and research assistantships available to qualified advanced graduate students which carry stipends of $2,700 or $3,240 per year for a ten or twelve-month appointment. 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 $2,700 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, Maryland 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 up to $2,500 per year. Such applications should be directed to the Director, Office of Student Aid, North Administration Building, University of Maryland, College Park, Maryland 20742.

Commencement

Attendance is required at the June commencement if the degree is conferred at that time.

Application for diploma must be filed in the Office of the Registrar eight weeks before the date at which the candidate expects to obtain a degree except during the summer session.

Academic costume is required of all candidates at the June commencement. 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 convocation 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; "I"—Incomplete. Since graduate students must maintain an over-all "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 degree is conferred.*

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

Fees

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

Programs and Courses

AEROSPACE ENGINEERING

Professors: Thomas, Corning, Rivello and Sherwood.
Associate Professors: Melnik and Schetz.
Assistant Professors: Donaldson and Plotkin.
Lecturers: Billig, Brandt, Lobb, Pai, Rush and Wilson.
Instructor: Orth.

The Department of Aerospace Engineering offers courses and opportunities for research leading to the degree 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.

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. (Melnik.)

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

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. (Melnik.)

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. (Corning.)

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. Linearized 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. (Pai.)

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). (Schetz.)

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 232, 233. Wave Propagation in Gases and Solids. (3, 3)
Prerequisite, permission of instructor. Application of method of characteristics to unsteady compressible flow. Study of isentropic and non-isentropic flows of both ideal and non-ideal gases. The Lagrange ballistic problem, detonation, the shock tube and spherical waves. Impact loading on elastic-plastic materials, the stopping shock, interactions and reflections in solids. Stress and strain produced in solids with varying cross-sectional area. (Seigel.)

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 flat 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. Advanced 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.)

F. GENERAL

ENAE 290. Seminar.
(Credit in accordance with work outlined by Aerospace Enginering 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 Areospace 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.

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. (Fairchild.)

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

For Graduates and Advanced Undergraduates

AGEC 103. Introduction To Agricultural Business. (3)
Second semester. (Lessley.)

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

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. (Suttor.)

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

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

AGEC 114. World Agricultural Production and Trade. (3)
First semester. (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. (Evans.)

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)
First 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. (McDonald.)

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. (Suttor.)

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. (McDonald.)

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. (Ishee.)

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 research. (Cain.)

AGEC 219. Advanced Land Economics. (3)
Second semester. Application of micro and macro economic principles to the analyses of special problems related to land such as public direction of land use, tenure arrangements, conservation, and land reform movements. (Wysong.)

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 analyses 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 and Burkhardt.
Associate Professors: Felton, Gienger, Harris, Schwiesow, and Winn.
Research Associate: Wheaton.

The Department of Agricultural Engineering offers a graduate course of study leading to the degree of Master of Science. The student may pursue major work in agricultural power and machinery, soil and water conservation engineering, agricultural structures or electric power and processing. A thesis based upon original research work is required. An employee of a nearby institution may submit a thesis based on research work at the institution under the direction of and with prior approval by the Department.

Laboratory facilities are available for work in each area of specialization and, in cooperation with other departments, ample areas for field tests and studies are available.

For Graduates and Advanced Undergraduates

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

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

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

AGEN 143. Agricultural Power and Machinery Analysis. (4)
First semester. Three lectures and one laboratory per week. Prerequisites, AGEN 001, ENES 001, and ENME 001. (Harris.)

AGEN 144. Design of Operational Systems for Agriculture. (3)
Second semester. Two lectures and one laboratory per week. Prerequisite, MATH 021 and PHYS 021. (Staff.)

AGEN 145. Soil and Water Conservation Engineering. (2)
Second semester. Two lectures per week. Prerequisites, ENCE 090 and ENME 102. (Schwiesow.)

AGEN 165. General Hydrology. (3)
Spring Semester. (Schwiesow.)

AGEN 175. Engineering Hydrology. (3)
Fall Semester—Prerequisites, MATH 066, ENCE 105 or ENME 102. (Schwiesow.)

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

For Graduates

AGEN 201. Special Topics in Agricultural Engineering. (3)
First and second semesters. Two lectures and one laboratory period per week. Timely topics in specialized areas of agricultural engineering will be selected. For example, Instrumentation for Agricultural Engineering Research. (Staff.)

AGEN 301. Special Problems in Agricultural 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. Prerequisite, permission of instructor. (Harris.)

AGEN 399. Thesis Research. (Master's Level)
Credit according to work accomplished. (Staff.)

AGRICULTURAL AND EXTENSION EDUCATION

Professors: Cardozier, Ryden.
Associate Professors: Longest, Nelson.

The Department of Agricultural and Extension Education offers programs leading to the Master of Science and Doctor of Philosophy degrees. The Master of Science with Thesis requires at least 24 semester hours of course work plus a six credit thesis. The Master of Science without Thesis requires at least 30 semester hours of course work plus a two or three credit master's problem.

The Doctor of Philosophy requires no specific number of credits; each student's program is planned in terms of his previous education, experience, special interests and future 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 satisfactory completion of two courses that aid one's research competence. French, German, Russian, Spanish and Danish are accepted languages. In agricultural education, one may orient his preparation toward teacher education, research, or administration and supervision. In agricultural education, one may orient his preparation toward teacher education, research, or administration and supervision. In extension education one may

orient toward personnel development, program development and administration, research and evaluation, or area and community development.

The Department also offers a program leading to the Advanced Graduate Specialist Certificate which requires 30 semester hours of course work beyond the master's degree. This is a professional program designed for those who desire additional training beyond the master's other than a doctorate.

Further information concerning requirements and procedures may be obtained from the Department.

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. (Cardozier.)

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 stu-

dent teaching program, responsibilities and duties of supervising teachers, and evaluation of student teaching. (Cardozier.)

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)
(Cardozier.)

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, Street, and Strickling.
Associate Professors: Clark, Deal, and Foss.
Assistant Professors: Fanning, and Schillinger.

The Department of Agronomy offers a graduate course of study leading to the degree 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 thesis based on original research is required for each 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. (2)
First semester, alternate years. (Offered 1968-69.) Prerequisite, BOTN 117 or ZOOL 006. (Schillinger.)

AGRO 104. TOBACCO PRODUCTION. (3)
Second semester. Three lectures a week. Prerequisite, BOTN 001. (Street.)

AGRO 107. CEREAL CROP PRODUCTION. (3)
First semester, alternate years. (Offered 1968-69.) Two lectures and one laboratory period a week. Prerequisite, BOTN 001. (Rothgeb.)

AGRO 108. FORAGE CROP PRODUCTION. (3)
Second semester. Two lectures and one laboratory period a week. Prerequisite BOTN 001. (Decker.)

AGRO 109. TURF MANAGEMENT. (3)
First semester, alternate years (Offered 1969-70). Two lectures and one laboratory period per week. Prerequisite, BOTN 001. (Deal.)

AGRO 151. CROPPING SYSTEMS. (2)
First semester. Two lectures a week. Prerequisite, AGRO 001 or equivalent. (Clark.)

AGRO 152. SEED PRODUCTION AND DISTRIBUTION. (2)
Second semester, alternate years. (Offered 1968-69.) One lecture and one laboratory period a week. Prerequisite, AGRO 001 or equivalent. (Newcomer.)

AGRO 154. WEED CONTROL. (3)
First semester, alternate years. (Offered 1969-70.) Two lectures and one laboratory period a week. Prerequisite. AGRO 001 or equivalent. (Parochetti.)

For Graduates

AGRO 201. ADVANCED CROP BREEDING. (2)
First semester, alternate years. (Offered 1969-70.) Prerequisite, AGRO 103 or equivalent. Genetic, cytogenetic, and statistical theories underlying methods of plant breeding. A study of quantitative inheritance, heterosis, heritability, interspecific and intergeneric hybridization, polyploidy, sterility mechanisms, inbreeding and outbreeding, and other topics as related to plant breeding. (Schillinger.)

AGRO 204. TECHNIC IN FIELD CROP RESEARCH. (2)
Second semester, alternate years. (Offered 1968-69.) 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 1969-70.) Two lectures a week. 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. (Street.)

AGRO 207. ADVANCED FORAGE CROPS. (2)
First semester, alternate years. (Offered 1968-69.) Two lectures a week. Prerequisites, 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 temperature, humidity, length of day, quality and intensity of light, wind movement, and defoliation practices. Relationship of these factors to life history, production, chemical and botanical composition, quality, and persistence of forages will be considered. (Decker.)

AGRO 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.)

AGRO S210. Cropping Systems. (1)
Summer session only. An advanced course primarily designed for teachers of vocational agriculture and county agents. It deals with outstanding problems and the latest developments in the field. (Staff.)

SOILS

For Graduates and Advanced Undergraduates

AGRO S110. Soil Management. (1)
Summer session only. An advanced course primarily designed for teachers of vocational agriculture and county agents dealing with factors involved in management of soils in general and of Maryland soils in particular. Emphasis is placed on methods of maintaining and improving chemical, physical, and biological characteristics of soils. (Strickling.)

AGRO 111. Soil Fertility Principles. (3)
First semester, alternate years. (Offered 1968-69.) Three lectures a week. Prerequisite, AGRO 010. A study of the chemical, physical, and biological characteristics of soils that are important in growing crops. Soil deficiencies of physical, chemical, or biological nature and their correction by the use of lime, fertilizers, and rotations are discussed and illustrated. (Strickling.)

AGRO 112. Commercial Fertilizers. (3)
Second semester. Three lectures a week. Prerequisite, AGRO 010 or permission of instructor. A study of the manufacturing of commercial fertilizers and their use in soils for efficient crop production. (Axley.)

AGRO 113. Soil and Water Conservation. (3)
First semester, alternate years. (Offered 1968-69). Two lectures and one laboratory period a week. Prerequisite, AGRO 010 or permission of instructor. A study of the importance and causes of soil erosion, methods of soil-erosion control, and the effect of conservation practices on soil-moisture supply. Special emphasis is placed on farm planning for soil and water conservation. The laboratory period will be largely devoted to field trips. (Foss.)

AGRO 114. Soil Classification and Geography. (4)
Second semester. Three lectures and one laboratory period a week. Prerequisite, AGRO 010, or permission of instructor. A study of the genesis, morphology, classification and geographic distribution of soils. The broad principles governing soil formation are explained. Attention is given to the influence of geographic factors on the development and use of soils in the United States and other parts of the world. The laboratory periods will be largely devoted to field trips and to a study of soil maps of various countries. (Fanning.)

AGRO 115. Soil Survey and Land Use. (3)
First semester alternate years. (Offered 1969-70). Two lectures and one two-hour laboratory a week. Prerequisite, AGRO 114 or consent of the instructor. An introduction to soil survey interpretation as a tool in land use both in agricultural and urban situations. The implications of soil problems as delineated by soil surveys on land use will be considered. (F. Miller.)

AGRO 116. Soil Chemistry. (3)
First semester, alternate years. (Offered 1968-69.) One lecture and two laboratory periods a week. Prerequisite, AGRO 010, or permission of instructor.

A study of the chemical composition of soils; cation and anion exchange; acid, alkaline and saline soil conditions; and soil fixation of plant nutrients. Chemical methods of soil analysis will be studied with emphasis on their relation to fertilizer requirements. (Axley.)

AGRO 117. Soil Physics. (3)
First semester, alternate years. (Offered 1969-70.) Two lectures and one laboratory period a week. Prerequisites, AGRO 010 and a course in physics, or permission of instructor. A study of physical properties of soil with special emphasis on relationship to soil productivity. (Strickling.)

AGRO 118. Soil Biochemistry. (3)
Second Semester, alternate years (Offered 1969-70). Two lectures and one two-hour laboratory period per week. Prerequisite, AGRO 010, CHEM 033 or 037 and 038 or consent of instructor. A study of biochemical processes involved in the formation and decomposition of organic soil constituents. Significance of soil biochemical processes involved in plant nutrition will be considered. (Bezdicek.)

For Graduates

AGRO 250. Advanced Soil Mineralogy. (3)
First semester, alternate years. (Offered 1968-69.) Three lectures a week. 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 1969-70.) Three lectures a week. 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 1969-70.) Two lectures and one laboratory period a week. 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 1968-69.) 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

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, alternate years. (Offered 1969-70) Two lectures and one two-hour laboratory a week. Prerequisite, CHEM 003 or consent of instructor.
(Siegrist.)

GEOL 121. Mineralogy. (3)
Second semester, alternate years. (Offered 1969-70) One lecture and two laboratories a week. Prerequisite, GEOL 004 and 120 or consent of instructor.
(Siegrist.)

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

Committee on American Studies: Manning, (*Chairman*).
Professor: Beall, (*Director of the Program*).
Associate Professors: Skramstad and Washburn.
Assistant Professor: Lounsbury.

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 in consultation with the chairman of the department in the field of the student's special interest. 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. (Beall.)

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

For Graduates

AMST 200. Introductory Seminar in American Studies. (3)

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

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

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

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

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

AMST 499. Dissertation Research. (Dcotral Level)

ANIMAL SCIENCE

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

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, 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. (Combs.)

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. (Buric.)

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 BOT 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 mutally 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. Physioiogy of Hatchability. (1)
See Poultry Science for description. (Shaffner.)

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

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

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 and Combs.)

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. (Combs.)

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

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

Professors: Levitine, Lembach, Lynch, and Maril.
Associate Professors: De Leiris, Gerdts, Gross, Jamieson, Longley, O'Connell, Rearick, and Stites.
Assistant Professors: Bunts, Bradley, Denny, Freeny, Grossman, O'Connor, and Pemberton.
Lecturers: Campbell, Griffin, Landgren.

The Department of Art offers a graduate program of study leading to the degree 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 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. Arts 280 is required.
2. A reading knowledge of two foreign languages, one of which must be either French or German (examination administered by 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. (Grossman.)
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.)

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. (Gross.)

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. (O'Connell.)

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.
(Gross, Grossman, Jamieson, Maril.)

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. Prerequiiste, ART 129.
139-a. Contemporary experimental techniques of one print medium with group discussions. (O'Connell.)
139-b. Continuation of 139-a. May be taken for credit after 139-a.
(O'Connell.)

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)
(Gerdts.)

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 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. Northern European Painting in the 15th and 16th Centuries. (3)
Painting in Flanders and related northern European areas, from Van Eyck to Brueghel and Durer. (Denny.)

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)
Architecture, 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 wil 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. (Grossman, Jamieson, Maril.)

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

ART 211. PRINTMAKING. (3)
Advanced problems. Relief process. (O'Connell.)

ART 212. PRINTMAKING. (3)
Advanced problems. Intaglio process. (O'Connell.)

ART 213. PRINTMAKING. (3)
Advanced problems. Lithographic process. (O'Connell.)

ART 214. SEMINAR IN PRINTMAKING. (3)
(O'Connell.)

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. (Gerdts.)

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

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. (Gerdts.)

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. (Gerdts.)

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

ART 272. Seminar—Problems in Medieval Iconogr..phy. (3)
Prerequisite, ART 166 or 167 or permission of instructor. Studies of selected problems in the religious meaning of Medieval iconography. Some reading knowlege 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). (Gerdts.)

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 Mexican 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: Matthews, v. P. Smith, and Wentzel.
Part-Time Professors: Brandt and Musen.
Assistant Professors: A'Hearn, Bell, Harrington, 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.

PRELIMINARY EXAMINATION.

Astronomy students will take a preliminary examination, preferably before they enter the Graduate School. A satisfactory score is required before the student is admitted to take the Ph.D. Qualifying Examination or admitted to candidacy for the M.S. The preliminary examination required is the Graduate Record Examination, Advanced Test in Physics, given several times per year by the Educational Testing Service, Princeton, N.J. The student must pass the examination within 15 months after entering the Department. The examination tests the adequacy of the student's undergraduate training in physics, deemed necessary for almost all fields of astronomy.

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 Ph.D. who have passed the Preliminary Examination and completed one year of graduate study. The normal time limit for passing for full-time students is three years, in special cases extended to four; for part-time students it is six years. The time limit for obtaining the Ph.D. is 7 years for full-time and 8 years for part-time students. For the M.S., these time limits are 5 and 6 years, respectively.

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 Ph.D. 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.

The Ph.D. minor may consist of one or two subjects closely related to the student's major field. An astronomy student may take his entire minor in Physics, but must always take Physics as his first minor (special rules apply to students of Mathematical Astronomy). For this, he has to take at least 12 credits of Physics courses, excluding 1-credit seminars. Especially recommended are:

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

Many other Physics courses of direct interest to Astronomy students are available.

If the student elects to take two minors, his second minor must consist of at least nine credits chosen from the following subjects, depending on his major field:

Theoretical Astronomy
Observational Astronomy
Mathematics
Meteorology
Computer Science
Electrical Engineering
Chemistry

It is advantageous to take one or two courses in Mathematics, even if Mathematics is not specifically chosen as a minor. Departmental approval has to be obtained for the choice of minor fields.

The Department also offers M.S. and Ph.D. degrees based on a program in Astrophysics. The study program for these degrees can be carefully 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, 3 credits of astronomy. An introduction to current methods of obtaining astronomical information including radio, infrared, optical, ultraviolet and x-ray astronomy. The laboratory work will involve photographic and photoelectric observations with the department's optical telescopes and 21-cm line 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.)

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.)

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 observations 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 atmposhere. Physics of solar phenomena, such as solar flares, structure of the corona, etc.
(Erickson, 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.)

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, Gauch, D. T. Morgan, Sisler, Stern, and Weaver.
Research Professor: Sorokin.
Associate Professors: Brown, Galloway, Kantzes, Klarman, Krusberg, Lockard, Mans, O. D. Morgan, and Rappleye.
Assistant Professors: Barnett, Bean, Curtis, Harrison, Karlander, Patterson, and Terborgh.
Research Associate Professor: Norton.
Instructors: Edwards, Owens, Pritchard.

The Department of Botany offers a graduate course of study leading to the degree of Master of Science and to the degree of 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.

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.)

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.)

For Graduates

BOTN 204. Growth and Development. (2)
First semester. (Not offered 1969-70). 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 1969-70). 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 1969-70). 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 219. Advanced Plant Ecology. (3)
Fall semester. (Not offered 1969-70). 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.)

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 1968-69) 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 1968-69). 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 1968-69). 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 MORPHOLOGY, CYTOLOGY, AND TAXONOMY

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

BOTN 115. Structure of Economic Plants. (3)
Second semester. (Not offered 1969-70). One lecture and two laboratory periods a week. Prerequisite, BOTN 111. (Rappleye.)

BOTN 116. History and Philosophy of Botany. (1)
First semester. Prerequisites, 20 semester hours credit in biological sciences, including BOTN 001 or equivalent.

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

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 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 1968-69.) 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 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.)

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.)

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.)

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 128. Mycology. (4)
Second semester. (Not offered 1969-70). (Lockard.)

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 1969-70). 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 1969-70). 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 1969-70). Prerequisites, Organic Chemistry and BOTN 101 or equivalent in bacterial or animal physiology. A study of various aspects of fungal metabolism, nutrition, biochemical transformations, fungal products, and mechanism of fungicidal action. (Sisler.)

BOTN 224. Physiology of Fungi Laboratory. (1)
First semester. (Not offered 1969-70). 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 1968-69). 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 1968-69). 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.)

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.)

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) (Staff.)

BUSINESS ADMINISTRATION

Profesors: Taff, Fisher, Gentry, Wright, Patrick, Dawson, Anderson, and Miner.
Associate Professors: Ashmen, Spivey, Hille, Lamone, Carroll, Nash, Paine, Olso, Hermanson, and Hynes.
Assistant Professors: Gannon, Lynagh, Olson, Hargrove, Keaton, Costella, Falthzik, Wims, McNitt, Himes, and Zabriskie.

The degree of Master of Business Administration is conferred on those students who satisfactorily complete the requirements which are 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 which are 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. Seminar coverage of outstanding current non-text literature, current problems and case studies in accounting.

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. Advanced accounting theory applied to specialized problems in partnerships, ventures, consignments, installment sales, insurance, statement of affairs, receiver's accounts, realization and liquidation reports, and consolidation of parent and subsidiary accounts.

BSAD 125. C.P.A. Problems. (3)
Prerequisite, BSAD 111, or consent of instructor. A study of the nature, form and content of C.P.A. examinations by means of the preparation of solutions

to, and an analysis of, a large sample of C.P.A. problems covering the various accounting fields.

BSAD 127. Advanced Auditing Theory and Practice. (3)
Prerequisite, BSAD 122. Advanced auditing theory and practice and report writing.

BSAD 128. Advanced Cost Accounting. (2)
Prerequisite, BSAD 121. A continuation of basic cost accounting with special emphasis on process costs, standard costs, joint costs and by-product costs.

BSAD 129. Apprenticeship in Accounting. (0)
Prerequisites, minimum of 20 semester hours in accounting and the consent of the accounting staff. A period of apprenticeship is provided with nationally known firms of certified public accountants from about January 15 to February 15, and for a semester after graduation.

BSAD 130. Business Statistics I. (3)

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

BSAD 132. Sample Surveys in Business and Economics. (3)
Prerequisite, BSAD 130 or equivalent. A course surveying the uses of statistics in economic and business research. The emphasis of the discussion is directed toward "cross-section" analysis as distinct from "time-series" analysis (which is given detailed attention in BSAD 135). Topics covered include: research methodology, sampling techniques and design, data-collection methods, questionnaire preparation, interviewing procedures, the evaluation of survey results, and a review of selected case studies.

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

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

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

BSAD 141. Security Analysis. (3)
Prerequisite, BSAD 140.

BSAD 143. Credit Management. (3)
Prerequisite, BSAD 140.

BSAD 148. Advanced Financial Management. (3)
Prerequisite, BSAD 140. An advanced course in finance. Emphasis is placed upon the techniques employed by executives in their application of financial management practice to selected problems and cases. Critical classroom analysis is brought to bear upon actual methods and techniques used by business enterprises.

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. Purchasing Management. (3)
Prerequisite, BSAD 149.

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

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

BSAD 157. International Marketing. (3)
Prerequisite, BSAD 149 and BSAD 192. Functions of various exporting agencies; documents and procedures used in exporting and importing transactions. Methods of procuring goods in foreign countries; financing of import shipments; clearing through the customs districts; and distribution of goods in the United States.

BSAD 158. Advertising Management. (3)
Prerequisite, BSAD 149. This course is concerned with the way in which business firms use advertising as a part of their marketing program. The case study method is used to present advertising problems taken from actual business practice. Cases studied illustrate problems in demand stimulation, media selection, advertising research, testing, and statistical control of advertising.

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)
Case method analysis of the modern law of industrial relations. Cases include the decisions of administrative agencies, courts and arbitration tribunals.

BSAD 165. Advanced Production Management. (3)
Prerequisite, BSAD 169. A study of typical problems encountered by the factory manager. The objective is to develop the ability to analyze and solve problems in management control of production and in the formulation of production policies. Among the topics covered are plant location, production planning and control, methods analysis and time study.

BSAD 166. Business Communications. (3)

BSAD 167. Operations Research I. (3)
Prerequisite, BSAD 130 or consent of instructor. (This course also listed as ISM 167 and may be taken for Information Systems Management credit.)

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. A critical examination of current government transportation policy and proposed solutions. Urban and intercity managerial transport problems are also considered.

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)
Designed primarily for CPA candidates. Legal aspects of wills, insurance, torts and bankruptcy. Offered only in Summer School.

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

BSAD 189. Business and Government. (3)
Prerequisites, ECON 032 or 037. A study of the role of government in modern economic life. Social control of business as a remedy for the abuses of business enterprise arising from the decline of competition. Criteria of limitations on government regulation of private enterprise.

BSAD 190. Risk Management. (3)
Designed to acquaint the student with the nature and significance of risk in business enterprise. The problems relating to both pure and speculative risk in business are considered; and methods of solution involving risk assumption transfer, reduction, and the use of insurance are analyzed as aids in management decision making.

BSAD 191. Principles of Risk and Insurance. (3)
Emphasizes the use of insurance in resolving problems involving personal and business risks. Life, accident and health, fire and casualty, automobile, and marine insurance are examined as means of dealing with these risks. The theory and legal aspects of insurance are considered, as well as the quantitative measurement of risks.

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 Polices. (3)

For Graduates

BSAD 210. Advanced Accounting Theory 1. (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.
(Note: BSAD 220 or BSAD 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, thru 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. 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.

(Note: BSAD 240 or BSAD 220 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, 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 con-

cepts 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 optimally fulfill 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 attenion 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 he 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 Formation. (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 (1 - 9) Independent Study in Business Administration.

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. Armstrong, Bhagat, Lippincott, Miller and Spain.

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, 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 of the materials program is not meant to be exhaustive but serves to illustrate the range of the 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. Funds are available for qualified individuals for appointments as research assistant and for post-doctoral fellowships.

The Center also participates in providing a concentration of studies in materials science in collaboration with these departments.

MATERIALS SCIENCE

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, Mechanical Engineering and the Institute for Molecular Physics. Detailed information may be obtained by writing the heads of these departments concerned.

CHEMICAL ENGINEERING

Professors: Beckmann, Bischoff, Duffey, Gomezplata, Johnson, Marchello, Schroeder, Silverman.
Associate Professors: Arsenault, Cadman, Munno, Skolnick, Smith.
Assistant Professors: Bolsaitis, Gentry, Regan.
Lecturers: Belcher, Goldman.

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. Courses in the subject areas of chemical, materials and nuclear engineering, applied polymer science and bioengineering are listed below.

The basic requirements for the degrees of Master of Science and Doctor of Philosophy are set forth on pages 27 and 33 of this catalog. Supplemental regulations for guidance of candidates for these degrees in the Department of Chemical Engineering are available in the department office.

APPLIED POLYMER SCIENCE

An interdisciplinary special area in polymer science is offered by the Department of Chemical Engineering leading to the degrees of Master of Science and Doctor of Philosophy. The program is open to qualified students holding bachelor 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. Courses to satisfy the minor requirements may be chosen from related courses in engineering, mathematics, and the pure sciences.

BIOENGINEERING

This special area is offered by the Department of Chemical Engineering as part of a joint effort with other engineering and interdisciplinary groups throughout the University. The program leading to the degrees of Master of Science and Doctor of Philosophy is open to qualified students holding Bachelor degrees in Chemical Engineering. Courses to satisfy the major requirements in Bioengineering are selected from the regular Chemical Engineering offerings with at least 6 hours of these being courses designated as Bioengineering. Courses to satisfy the minor may be chosen from Chemistry, Physics, Mathematics, Biological or Medical Sciences, or other engineering fields with the approval of the Department.

ENGINEERING MATERIALS

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 Chemistry, Physics, Mathematics or other engineering courses including chemical and mechanical engineering.

NUCLEAR ENGINEERING

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 Chemistry, Physics, Mathematics, or other engineering courses including chemical engineering.

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 tech-

nique 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. (Gomezplata.)

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. NUMERICAL AND STATISTICAL ANALYSIS. (2)
First semester. Prerequisite, ENCH 116. Use of probability and statistics in chemical engineering. Probability, normal distribution and measure of variability. The chi square, and the t-test. Correlation and regression analysis. Introduction to analysis of variance and sequentral analysis. (Smith.)

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. (Smith.)

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. (Glomb.)

ENCH 253. ADVANCED TOPICS IN THERMODYNAMICS. (3)
Second semester. Prerequisite, CHEM 203. (Staff.)

TRANSPORT AND TRANSFER PHENOMENA

For Graduates and Advanced Undergraduates

ENCH 127, 129, 131. TRANSFER AND TRANSPORT PROCESSES I, II, III. (4, 3, 3)
First, second, and first semesters, respectively. Prerequisite. ENCH 050. A three semester sequence of courses concerning the 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. Steady and unsteady state diffusion and conduction, simultaneous heat and mass transfer, interphase transfer, boundary layer theory. The equilibrium stage concept and its application to absorption, extraction, and distillation. Analysis of multiple stage processes. Principles of radiant heat transfer, evaporation, filtration, crystallization, drying, condensation, boiling, humidification, ion exchange, and phase separations. (Smith, Marchello, Regan.)

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. (Marchello, Bischoff.)

ENCH 207. Transfer Operations. (3)
Second semester. Prerequisite, ENCH 205. Applications of heat, mass and momentum transfer theory to chemical engineering problems. Transfer coefficients; heat, mass and momentum analogies; two-phase flow; boiling and condensation; radiation heat transfer. (Marchello, Regan.)

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

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. (Bischoff.)

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. Advacned 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. (Glomb.)

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 modes 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 Laroratory. (1)
Second semester. Prerequisite, ENCH 157 concurrently. Methods of process control. Use of experimental and mathematical models of control systems. (Cadman.)

ENCH 161. Unit Operation and Processes of Air Pollution Control. (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.)

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.)

ENGINEERING MATERIALS

For Graduates and Advanced Undergraduates

ENCH 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.)

ENCH 171. Physical Chemistry of Engineering Materals. (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.)

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

ENCH 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

ENCH 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.)

ENCH 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. (Staff.)

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

ENCH 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.)

ENCH 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.)

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

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. (Smith.)

ENCH 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.)

ENCH 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 considerd in terms of fundamental material properties. (Arsenault.)

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

ENCH 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.)

ENCH 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.)

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

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. (Smith.)

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

NUCLEAR ENGINEERING

For Graduates and Advanced Undergraduates

ENCH 140. Introduction to Nuclear Technology. (2)
First and second semesters. Two lectures a week. Prerequisites, MATH 021 and PHYS 021. Engineering problems of the nuclear energy complex, including basic theory, nuclear reactor design, and isotopic and chemical separations. Emphasis is on the nuclear fission reactor. (Staff.)

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 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.)

For Graduates

ENCH 302, 303. Nuclear Reactor Engineering. (3, 3)
First and second semesters. Three lectures a week. Prerequisite, permission of

instructor. Design, construction and operation of typical nuclear reactors including general design, nuclear reactor theory, materials of construction, heat transfer, and control. (Staff.)

ENCH 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.)

ENCH 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.)

ENCH 313. Selected Topics in Nuclear Engineering. (2)
Two lectures a week. Prerequisite, permission of instructor. Topics of current interest and recent advances in the nuclear engineering field. Because of the rapid advances in the field, information on special topics of much practical importance is continually becoming available. Since the content changes, reregistration may be permitted. (Staff.)

ENCH 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.)

ENCH 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.)

ENCH 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 theoreticaly treated utilizng the diffusion approximation, the Fermi Age method and the P-3 method. Elementary temperature and time dependence. (Munno.)

ENCH 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.)

ENCH 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 prob-

lems. Spherical harmonic and variational methods. Special methods of solving transport equations. (Munno.)

ENCH 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.)

ENCH 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 for simulation and problem solving. (Staff.)

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 polymer 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 applcations. (Smith.)

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

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

ENCH 247. Special Problems in Chemical Engineering.

ENCH 314. Special Problems in Nuclear Engineering.

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

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

ENCH 499. Dissertation Research. (Doctoral Level)

CHEMISTRY

Professor and Head: Vanderslice*
Professor and Associate Head: Jaquith.
Professors: Atkinson, Benedict*, Grim, Keeney, Lippincott, Pratt, Purdy, Reeve, Rollinson, Stewart, Svirbely, Veitch, and White.
Research Professors: Bailey, Zwanzig*.
Associate Professors: Boyd, DeRocco*, Gardner, Henery-Logan, Holmlund, Huheey, Kasler, Krisher*, Lakshmanan, Munn*, Pickard, Sengers*, Stuntz, and Viola.
Assistant Professors: Bellama, Carruthers, Ginter*, Jackson, Jarvis, Khanna, Mazzocchi, Miller, O'Haver, Spain*, Staley, and Verbeke.

The Chemistry Department offers programs leading to the M.S. or the Ph.D. degrees in analytical chemistry, 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 M.S. and Ph.D. 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.

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.)

* Member of the Institute for Molecular Physics.

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. (Staff.)

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. Prerequiste, 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.)

CHEM 111. Chemical Principles. (4)
Two lectures and two three-hour laboratory periods per week. Prerequisite, CHEM 003, or equivalent. Not open to students seeking a major in the physical sciences, since the course content is covered elsewhere in their curricula. A course in the principles of chemistry with accompanying laboratory work consisting of simple quantitative experiments. (Credit applicable only toward degree in College of Education.) (Jaquith.)

CHEM 112, 113. Special Problems in Chemistry Teaching. (3,3)
One four-hour meeting per week. An intensive study of secondary school chemistry courses with particular attention to the Chemical Education Material Study course. Major emphasis will be placed on the chemical principles and the philosophy underlying the CHEM Study program. Credit applicable toward degrees in the College of Education only. Prerequisite, CHEM 001, 003 or its equivalent, and enrollment in the NSF In-Service Institute for Secondary School Chemistry Teachers, or consent of the instructor. (Jaquith.)

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. (White.)

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

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. (Viola.)

ORGANIC CHEMISTRY

For Graduates and Advanced Undergraduates

CHEM 115. A Survey of Organic Chemistry. (3)
Summer School only. Open ONLY to registrants in the National Science Foundation Summer Institute. Five one-hour lectures per week; five three-hour laboratory periods per week. A systematic survey of compounds of carbon at the elementary level. (Staff.)

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 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 241. Stereochemistry. (2)
Two lectures per week. (Staff.)

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 249. Physical Aspects of Organic Chemistry. (2)
Two lectures per week. (Staff.)

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

CHEM 254. Advanced Organic Preparations. (2-4)
Two or four three-hour laboratory periods per week. (Pratt.)

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 017, 019 or 021; PHYS 021; 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.)

For Graduates

The common prerequisites for the following courses are CHEM 187 and 189. One or more courses of the group, 281-323, will be offered each semester depending on demand.

CHEM 281. Theory of Solutions. (2)
Two lectures per week. Prerequisite, CHEM 307 or equivalent. (Svirbely.)

CHEM 285. Colloid Chemistry. (2)
Prerequisite, CHEM 189 or equivalent. Two lectures per week. (Pickard.)

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

CHEM 295. Heterogeneous Equilibria. (2)
Prerequisite, CHEM 189 or equivalent. Two lectures per week. (Pickard.)

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, and Otts.
Associate Professors: Cookson, Cournyn, Garber, Gohr, Kondner, Piper, Ragan, and Wedding.
Assistant Professors: Birkner, Heins, Israel, Reilly, and Schelling.
Instructor: Dunphy.
Lecturers: Bloem, Byington, Desrosiers, and Rajan.

The Civil Engineering Department offers graduate work leading to the degrees of Master of Science and Doctor of Philosophy. Courses and research opportunities are available in the subject areas of civil engineering materials, transportation and highway engineering, hydraulic engineering, sanitary and environmental health engineering, soils and foundations, and structural 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 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 104. Computer Analysis. (3)
Two lectures and one laboratory each week. Prerequisites, ENCE 100 and ENCE 102. (Garber.)

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 and Cookson.)

ENCE 107. Fundamentals of Soil Mechanics. (3)
Three lectures each week. Prerequisites, ENES 020 and ENCE 050. (Kondner.)

ENCE 108. Fundamentals of Transportation Engineering. (3)
Prerequisite, ENCE 050 and ENCE 090. (Byington, Wedding.)

ENCE 109. Basic Civil 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. (Schelling.)

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.
(Kondner.)

ENCE 136. Soil-Foundation Systems. (3)
Three lectures each week. Prerequisites: ENCE 107, 135 or equivalent with permission of instructor. (Kondner.)

ENCE 145. Advanced Fluid Mechanics. (4)
Three lectures and one laboratory each week. Prerequisite, ENCE 105.
(Cournyn, Rajan.)

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. (Ragan.)

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.)

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 185. Highway Engineering. (3)
Three lectures each week. Prerequisite, ENCE 107. (Wedding, Dunphy.)

ENCE 186. Transportation Engineering. (3)
Three lectures each week. Prerequisite, ENCE 108. (Wedding, Dunphy.)

ENCE 187. Engineering Analysis of Transportation Systems I. (3)
Three lectures each week. Prerequisites, ENCE 186 or consent of instructor. (Staff.)

ENCE 188. Engineering Analysis of Transportation Systems II. (3)
Three lectures each week. Prerequisite: ENCE 186 or consent of instructor. (Staff.)

ENCE 195. Advanced Surveying. (3)
Two lectures and one laboratory each week. Prerequisite, ENCE 090. (Staff.)

ENCE 199. Special Problems. (3)
Prerequisite, senior standing. (Staff.)

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. Expermental 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 material methods; analogies; 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 241. Hydraulic Engineering. (3)
Prerequisite, ENCE 105 or equivalent. Water power and flood control. Analysis of the principal features of a water power project with special reference to reservoir, waterway, dam, plant accessories, and power house equipment. Complete report on a water power project required, including costs and power valuation. (Cournyn.)

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 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 foundations. 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. Numerical 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. (Schelling.)

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 flexiblity 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 hyper-

bolic 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 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 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 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 anaerobic 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 equilbria, 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 destabilization of colloidal materials, ion exchange, disinfection, chemical oxidation and oxygenation reactions. (Birkner.)

ENCE 279. Air Pollution. (3)
Prerequisite; consent of instructor. Evaluation of the capacity of the atmosphere to assimilate the waste materials from an industrial society. The classification of pollutants and identification of specific emission sources will be considered together with the physiological effects of specific pollutants on plants, animals, and humans. Consideration will also be given to techniques and devices which have been devised for the sampling and control of particular emissions. (Israel.)

ENCE 280. Air Sampling and Analysis. (3)
Prerequisite ENCE 279 or consent of instructor. Two lectures and one laboratory a week. The theory and techniques utilized in the determination and measurement of chemical, radiological and biological pollutants in the atmosphere. Theory of particle deposition by diffusion, impaction, sedimentation and thermal and electrical forces, application to aerosol sampling with description of aerosol sampling devices and data evaluation. (Israel.)

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. (Desrosiers.)

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. (Desrosiers.)

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. (Desrosiers.)

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. (Desrosiers.)

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.)

ENCE 296, 297. Engineering Analysis and Computer Programming. (3, 3)
Prerequisite, consent of instructor. Applications to elasticity, stability and

buckling, vibrations, thin plates and shells, or other problems in the area of mechanics, structures and materials. (Schelling.)

ENCE 298. Seminar.
Credit in accordance 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 Clasical 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 Language. Reports. (Avery.)

COMPARATIVE LITERATURE

Professors: Cooley, Freedman, Goodwyn, G. Jones, Korg (*Visiting*), Levitine, Prahl, Salamanca, Schaumann, D. Smith, 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, M.A. thesis, and Ph.D. dissertation requirements for the M.A. and Ph.D. degrees in Comparative Literature may be obtained from the Comparative Literature 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 Michael McCaskey, Chinese; Professor George Panichas, English; and Professor Denzell Smith, English. 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)

CMLT 102. Introductory Survey of Comparative Literature. (3)

CMLT 103. The Old Testament as Literature. (3)

CMLT 105. Romanticism: Early Stages. (3)

CMLT 106. Romanticism: Flowering and Influence. (3)

CMLT 107. The Faust Legend. (3)

CMLT 112. Ibsen and the Continental Drama. (3)

CMLT 114. Greek Drama. (3)

CMLT 115. The Classical Tradition and Its Influence in the Middle Ages and Renaissance. (3)

CMLT 116. The Classical Tradition and Its Influence in the Middle Ages and Renaissance. (3)

CMLT 125. Literature of the Middle Ages. (3)

CMLT 130. The Continental Novel. (3)

CMLT 135. Dante and the Romance Tradition. (3)

CMLT 140. Literature of the Far East. (3)

CMLT 141. Literature of the Far East. (3)

CMLT 145. Major Contemporary Authors.

CMLT 150. Conference Course in Comparative Literature. (3)

For Graduates

CMLT 201. Problems in Comparative Literature. (3)

CMLT 225. Medieval Epic. (3)

CMLT 226. The Medieval Romance. (3)

CMLT 230. Problems of the Baroque in Literature. (3)

CMLT 235. Seminar in Italian Renaissance and Its Influence. (3)

CMLT 240. Literary Criticism: Ancient and Medieval. (3)

CMLT 241. Literary Criticism: Renaissance and Modern. (3)

CMLT 258. Folklore in Literature. (3)

CMLT 268. Seminar in Literary Sources of Art History. (3)

CMLT 301. Seminar in Themes and Types. (3)

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

CMLT 499. Dissertation Research. (Doctoral Level)

COMPUTER SCIENCE

Professors: Atchison (*Director of the Computer Science Center*), Chu*, Edmundson**, Glasser[1], and Heilprin[2].
Research Professors: Rheinboldt[3] and Rosenfeld.
Associate Professors: Glaser[4] and Minker.
Research Associate Professor: Ortega.
Assistant Professors: Austing, Owings**, Pfaltz, Schneider, and Vandergraft.

The educational program in computer science is administered by the Computer Science Center which is an academic department of the University not affiliated with any particular school or college. The Computer Science Center offers a Master of Science degree in computer science and also sponsors jointly with the Department of Electrical Engineering a Master of Science degree pro-

* 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

gram in Computer Systems Engineering. The Center also provides computing service for all academic activities of the University and conducts an active research program in the computer and computer related sciences.

Students applying for admission are expected to have at least a computer science background comparable to the contents of CMSC 100 and a mathematics background consisting of a minimum of one course beyond the basic calculus sequence. Additional preparation is desirable in as many of the following areas as possible: CMSC 140, CMSC 150, CMSC 166, linear and abstract algebra, combinatorial mathematics, graph theory, mathematical logic, probability and statistics, numerical methods, digital circuit design, computer logic design, switching theory, mathematical or structural linguistics, and the psychology of learning.

For additional information on admission and degree requirements on current developments in a Computer Science Ph.D. Program, and on financial support, students should write to the Admissions and Financial Awards Committee of the Center.

For Graduates and Advanced Undergraduates

CMSC 100. Language and Structure of Computers. (3)
Two lectures and one two-hour laboratory period per week. Prerequisite, CMSC 012 or CMSC 020 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 projtcts to illustrate basic concepts. (Staff.)

NOTE: CMSC 100 may not be counted for credit in the graduate program in computer science.

CMSC 102. Introduction to Discrete Structures. (3)
Prerequisite, CMSC 020 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. (Pugsley, Rheinboldt, and Vandergraft.)

NOTE: CMSC 102 may not be counted for credit in the graduate program in computer science.

CMSC 110. Special Computational Laboratory. (1 or 2)
Two hours laboratory per week for each credit hour. Prerequisite, CMSC 012 or equivalent. Arranged for special groups of students to give experience in developing algorithmic solutions of problems or using particiular computational systems. May be taken for cumulative credit up to a maximum of six hours where different material is covered. (Staff.)

NOTE: CMSC 110 may not be counted for credit in the graduate program in computer science.

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. (Schneider.)

CMSC 144. Elementary Logic and Algorithms. (3)
Prerequisite, MATH 021 or consent of instructor. This is the same course as MATH 144. An informal development of propositional logic, predicate logic, set algebra, and Boolean algebra. Topics include recursive functions, Turing machines, Post productions, Markov algorithms, and word problems. (Edmundson.)

CMSC 150. Data and Storage Structures. (3)
Prerequisite, CMSC 100 and CMSC 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. (Minker.)

CMSC 166. Functional Organization of Digital Computer Systems. (3)
Prerequisite, CMSC 100 or ENEE 162 or equivalent. This is the same course as ENEE 166. Computer organization and configuration; interconnection of sub-units into a computer system; arithmetic logic; storage structure and logic; control and sequencing; input-output systems. A small computer and a modern large-scale computer system will be used to illustrate these concepts. Each student will be expected to complete a project. (Chu.)

CMSC 168. Numerical Methods for Scientists and Engineers. (3)
Prerequisites, MATH 022 or 162, MATH 066, and CMSC 020 or equivalent. This course is the same 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. (Vandergraft.)

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.)

For Graduates

CSMC 200. Computer and Programming Systems. (3)
Prerequisites, CMSC 140, 150, and 166. 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 multi-processor computers. Addressing techniques, storage allocation, file management, system accounting, and user-related services; command languages and the embedding of subsystems. Operating characteristics of large-scale systems. (Staff)

CMSC 215. Theory of Computation. (3)
Prerequisites, CMSC 100 and 102 or equivalent. Introduction to Turing machines, Wang machines, Sheperdson-Sturgis and other machines. Godel numbering and unsolvability results, the halting problem, Post's correspondence problem, and relative uncomputability. Machines with restricted memory access, limited memory, and limited computing time. Complexity classification

and recursive function theory. Models of computation including the relationship to algorithms and programming. (Edmundson, Owings)

CMSC 225. Computer Applications to the Physical Sciences. (3)
Prerequisites, CMSC 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. (Glasser)

CMSC 230. Simulation of Computer Organization. (3)
Prerequisite, CMSC/ENEE 166 or equivalent. Computer design language, algorithmic and symbolic designs of stored-program computer logic, simulation of the designed computer, machine language programming, design and construction of an assembler for the simulated computer, assembly language programming. (Chu)

CMSC 235. Modeling and Simulation of Physical Systems. (3)
Prerequisite, CMSC 100 and a course in probability or mathematical statistics. Monte-Carlo and other methods of investigating models of interest to physical scientists. Generation and testing or random numbers. Probabilistic, deterministic and incomplete models. (Glasser)

CMSC 240. Compiler Construction. (3)
Prerequisite, CMSC 102, 140, 150. Review of assembly, loading and execution of programs including macros, data types and statements, block structure and storage allocation, procedures and functions. Organization of a compiler including symbol tables, lexical scan, syntax scan, object code generation, error diagnostics, and optimization techniques. Use of compiler writing languages and bootstrapping. (Staff)

CMSC 245. Formal Languages and Syntactic Analysis. (3)
Prerequisite, CMSC 102, 140, 150. Definition of formal grammars: arithmetic expressions and precedence grammars, context-free and finite-state grammars. Algorithms for syntactic analysis: recognizers, back-tracking, operator precedence techniques. Semantics of grammatical constructs: reductive grammars, Floyd productions, simple syntactical compilation. Relationship between formal languages and automata. (Edmundson, Schneider.)

CMSC 258. Seminar on Information Retrieval. (3)
Prerequisite, CMSC 100 or permission of instructor. This is the same course as LBSC 258. Discussion of basic constraints on communications, sensing and modulating rates, effects of constraints on structure and function of information storage and retrieval systems, models and analysis, aspects of automatic information retrieval. Term paper on subject of student's interest and instructor's approval. (Heilprin)

CMSC 263. Theory of Sequential Machines. (3)
Prerequisite, CMSC 102, and CMSC 100 or ENEE 162. This is the same course as ENEE 263. Definition and representation of finite automata and sequential machines, equivalence of states and machines, congruence and reduced machines, analysis and synthesis of machines, decision problems of finite automata, partitions and the substitution property, generalized and incomplete machines, semigroups and machines, and other selected topics. (Owings, Pugsley)

CMSC 266. Algorithmic Numerical Analysis. (3)
Prerequisites, CMSC 100 and MATH 170-171. A detailed study of problems which arise in the implementation of numerical analysis algorithms in a com-

puter. Rounding and truncation error. Automatic error estimates using interval arithmetic and convergence theorems. Examples from linear algebra, differential equations, systems of nonlinear algebraic equations, minimization. (Ortega)

CMSC 280. Artificial Intelligence. (3)
Prerequisites, CMSC 102 and MATH 100, or permission of instructor. Critical review of major developments in neuromimes and brain models, trainable devices, "self-organizing" systems. Representative applications to prediction, decision making, pattern recognition, natural language processing, theorem proving and game playing. Class and individual projects to illustrate basic concepts. (Rosenfeld)

CMSC 285. Computer Processing of Pictorial Information. (3)
Prerequisite, CMSC 150 or permission of instructor. Objective and subjective aspects of pictorial information. Picture quality and its assessment; image enhancement. Picture redundancy; quantization, encoding and approximation of pictures. Picture description and pictorial pattern recognition. Input and output of pictorial information. Computer projects illustrating typical processing techniques as applied to black-and-white images. (Rosenfeld)

CMSC. 290. Advanced Topics in Computer Science. (3)
Prerequisite, permission of instructor. Advanced topics selected by the faculty from the literature of computer science to suit the interest and background of students. May be taken for repeated credit. (Staff)

CMSC 295. Graduate Seminar in Computer Science. (1-3)
Prerequisite, permission of instructor. Seminars are held on topics such as language design, translator theory, data systems, organization of computer systems, and automatic problem solving. May be taken for repeated credit. (Staff)

CMSC 399. Thesis Research. (Arranged) (Staff)

DAIRY SCIENCE

Professors: Arbuckle, Cairns, Cason, Davis, Hemken, Keeney, King and Matrick.
Associate Professors: Williams, Vandersall.
Assistant Professor: Fairchild.

The Department of Dairy Science offers work leading to the degree of Master of Science and Doctor of Philosophy. Candidates for the Doctor of Philosophy degree have the option of studying in one of two major fields: dairy production, which is concerned with breeding, nutrition and physiology of dairy animals, or dairy technology, which is concerned with chemical, bacteriological, and nutritional aspects of dairy products, as well as the industrial phases of milk processing. Students interested in food science may undertake graduate study in the dairy technology phase of Dairy Science, or in the Food Science curriculum.

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. (Helbacka.)

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. (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)
(Combs.)

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. Physiology of Milk Secretion. (2)
Second semester. One lecture and one three-hour laboratory period per week. Prerequisite, ZOOL 102 or 104. (Williams.)

ANSC 142. Dairy Cattle Breeding. (3)
Second semester. Two lectures and one laboratory period per week. Prerequisites. ANSC 040, ZOOL 006, or BOTN 117. A specialized course in breeding dairy cattle. (Fairchild.)

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.)

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. (Keeney.)

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. (Creek.)

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

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

ANSC 266. Physiological Genetics of Domestic Animals. (2)
See Poultry Science for description.

ANSC 301. Special Problems in Animal 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, O'Connell, Schultze, Ulmer, and Wonnacott.
Associate Professors: Aaron, Bennett, Bergmann, Dodge, Dorsey, Harris, Knight, McGuire, Olson, and Weinstein.
Assistant Professors: Adams, Boorman, Canterbery, Clauge, Greer, Havrilesky, Hexter, Mayor, Meer, Meyer, Qualls, and Singer.
Lecturers: Amuzegar, Bell, Green, Hinrichs, Lower, Measday, Moore, Mueller, Pierce, Schink, Shipley, Snow, and Strober.

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, in the fall: Economics 200, Micro-economic Theory I; Economics 202, Macro-economic Theory; and Economics 211, Quantitative Economics I. In the spring, these are followed by: Economics 201, Micro-economic Theory II; Economics 247, Economic Growth and Instability; and Economics 212, Quantitative Economics II. For students with assistantships, or internships, three courses constitute full-time work. Students who can devote all their time to courses normally take four.

DOCTOR OF PHILOSOPHY

1. *Written Theory Examination.* At the beginning of his second year, the doctoral student should take a two-part written examination in economic theory. The examination may be repeated if necessary, but it must be passed before the student can take the comprehensive examination described below. These examinations will be given in September and April.

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) and (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 major paper should, if possible, lead into a Ph.D. thesis. It must be typed in the physical form specified by the Thesis Manual of the Graduate School for a thesis and it must be presented at the oral comprehensive examination. The student must register for six hours of thesis supervision. He will, of course, usually need other courses and seminars to prepare for the comprehensive examinations.

3. *Comprehensive Examinations.* The Ph.D. candidate must pass written examinations in two fields selected, with the approval of his adviser, from the following list. His adviser will insist on balance in the choice of fields.

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 May. Students should sign up for them in mid-September or mid-April. After passing the written examinations, the candidate must take an oral examination on his major paper, economic theory, and the two optional fields. Upon passing this examination, he will be awarded the M.A. degree, unless he already holds one in economics from another institution. Upon the recommendation of the examining committee (when approved by the Graduate Council), he will be admitted to candidacy for the Ph.D.

4. *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.

5. *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 Statistics may replace one language. See the general statement about foreign language requirements elsewhere in this catalog.

6. *Minor Requirements.* A program satisfying the above requirements automatically satisfies the Graduate School's major and minor requirements.

MASTER OF ARTS, THESIS OPTION

Under this option for the Master's Degree, the student must pass twenty-four 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 twelve 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. (The Master's Degree earned in this way does not qualify the student to be admitted to candidacy for the Ph.D.)

MASTER OF ARTS, NON-THESIS OPTION

Under this option, the candidate must: (a) pass ECON 211 and 212 with a grade of "B" or better; (b) pass the written portion of the comprehensive theory examination which is part of the Ph.D. program; (c) prepare a 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); and (d) pass with an average grade of "B" or better at least 30 hours of courses—24 of these must be in graduate-level courses.

ADMISSION

Applications for financial assistance must be received by March 1 for support beginning in September. Applications for admission 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 examination may be obtained from the Educational Testing Service, Princeton, New Jersey. 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 intending to be part-time students should bear in mind that nearly all of the graduate courses are taught during the day and that the minimum admissable course load requires about thirty hours a week of work.

Inquiries should be directed to the Director of Graduate Studies, Department of Economics.

For Graduates and Advanced Undergraduates

ECON 102. National Income Analysis. (3)
First and second semesters. Prerequisite, ECON 032. (Mayor, Schink, Staff.)

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, Lower.)

ECON 106. Economic Development of Selected Areas. (3)
Prerequisite, ECON 105. ECON 106A—Latin America; ECON 106B—Asia; ECON 106C—Africa. (Bennett, Adams.)

ECON 111. Quantitative Methods in Economics. (3)
(Boorman.)

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. (Hexter.)

ECON 131. Comparative Economic Systems. (3)
First and second semesters. Prerequisite, ECON 032 or 037.
(Gruchy, Lower, 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.
(Ulmer, O'Connell, Staff.)

ECON 134. Contemporary Economic Thought. (3)
Prerequisite, ECON 032 and senior standing. (Gruchy, Lower.)

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 140. Money and Banking. (3)
First and second semesters. Prerequisite, ECON 032.
(Meyer, Havrilesky, Boorman.)

ECON 141. Theory of Money, Prices and Economic Activity. (3)
Second semester. Prerequisite, ECON 102, 132, and 140 or consent of instructor. (Havrilesky, Meyer.)

ECON 142. Introduction to Public Finance. (3)
First and second semesters. Prerequisite, ECON 032. (Meer, Singer.)

ECON 143. Theory of Public Finance. (3)
Second semester. Prerequisite, ECON 142, 102 and 132, or consent of instructor.
(Aaron, Singer.)

ECON 144. State and Local Public Finance. (3)
Prerequisite, ECON 032 or 037.

ECON 147. Business Cycles. (3)
First semester. Prerequisite, ECON 102. (Mayor.)

ECON 148. International Economics. (3)
First and second semesters. Prerequisite, ECON 032.
(Wonnacott, Clague, Moore.)

ECON 149. International Economic Policies. (3)
Prerequisite, ECON 148, 102, and 132, or consent of instructor. (Canterbery.)

ECON 160. Labor Economics. (3)
First and second semesters. Prerequisite, ECON 032. (Knight, Strober.)

ECON 161. Current Problems in Labor Economics. (3)
Second semester. Prerequisite, ECON 160. (Weinstein, Knight.)

ECON 170. Industrial Organization. (3)
Prerequisite, ECON 032 or 037. (Qualls, Greer.)

ECON 171. Economics of American Industries. (3)
Second semester. Prerequisite, ECON 032 or 037. (Measday, Greer.)

ECON 196, 197. Honors Seminar. (3, 3)
First and second semesters. Normally taken in the junior year. Prerequisite, candidacy for honors in Economics. Selected topics are investigated, and written reports are submitted. (Knight.)

ECON 198. Independent Honors Study. (3)
First semester. Normally taken in the senior year. Prerequisites, ECON 196, 197 and candidacy for honors in Economics. Integrated reading under staff direction, leading to the preparation of a thesis in ECON 199. (Staff.)

ECON 199. Honors Thesis. (3)
Second semester. Prerequisites, ECON 198 and candidacy for honors in Economics. General supervision will be provided through assembled meetings with the professor in charge of the course. (Staff.)

For Graduates

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. Competitive model and the theory of imperfect competition. Central problem of welfare economics and general equilibrium. Detailed analysis of the theory of production and consumption. An acquaintance with calculus or concurrent enrollment in ECON 211 is presumed. (Ulmer, Almon, Pierce.)

ECON 201. Advanced Micro-Economic Analysis. (3)
Second semester. Prerequisite, ECON 200. A continuation of ECON 200. Theory of wages, capital and interest. 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 economics. (Ulmer, Almon, Pierce.)

ECON 202. Macro-Economic Analysis. (3)
First semester. ECON 202 and 247 form a two-semester sequence in macroeconomic theory. Aggregate general equilibrium theory, including an analysis of alternative theories—classical, Keynesian, and their more recent refinements. (Bergmann, Mayor, Pierce.)

ECON 203. Seminar in American Economic Development. (3)
Second semester. Selected topics in the long-term movements of the American economy. Quantitative studies of the growth of output; applications of econometric methods and economic theory to topics in American economic history.

ECON 204. Origins and Development of Capitalism. (3)
First semester. Study of the transition from feudalism to capitalism and the subsequent development of leading capitalist institutions in industry, agriculture, commerce, banking and the social movement. (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.)

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. (Hinrichs, 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, Meer.)

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, Hexter, 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, Hexter, 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. Multisectoral growth models and questions of optimal growth. 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. (Hexter, Bell.)

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. (Bell.)

ECON 220. Advanced Regional and Urban Economics. (3)
First semester. Location theory and the spatial distributions of economic activity. The application to problems of natural resource management, environmental

quality, and regional and interregional development of such analytic methods as input-output techniques, social accounting systems, and industrial complex analysis. (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, the United Kingdom, and the Scandinavian 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 economic administration, manpower and wage policies, foreign trade and aid. Selected topics in Bloc development. (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 the mechanisms through which central banking affects economic 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 production, exchange and consumption. Principles of benefit-cost analysis for government decisions. (Schultze, McGuire.)

ECON 243. Seminar in Public Finance. (3)
Theory of taxation; empirical studies with reference primarily to the United States. The burden of the public debt. Budget concepts and their relationship to fiscal policy. (Aaron.)

ECON 245. Economics of Defense. (3)
Prerequisite, ECON 200. Defense systems analysis. A review of the program-budget system and an evaluation of resource management in the defense program.

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. A continuation of ECON 202 with emphasis on the theory of economic growth in developed economies; the basic Harrod-Domar models and more complex ones, both neoclassical (Solow, Tobin) and Keynesian (Kaldor, Champernowne). Models of embodied technological progress and various input-augmenting formulations. The empirical aspects of the course focus on the problem of estimating sources of economic growth, parameters of production functions, and the rate and character of technological advance.
(Bergmann, Mayor, Schultze.)

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.

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. (Weinstein.)

ECON 261. Selected Topics in Labor Economics. (3)
Second semester. Variation in labor market and labor organization; labor in stages of economic development; manpower development. Aggregate problems of price and employment stability. Alternative theories of public policy toward labor markets. (Knight.)

ECON 266. Seminar in the Economics of Human Resources. (3)
Prerequisite, consent of the instructor. (Weinstein.)

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.
(Mueller, Qualls.)

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. (Mueller, Qualls.)

ECON 399. Thesis Research.
Arranged.

ECON 499. Dissertation Research.

EDUCATION

Professors: V. E. Anderson, Berman, Blough, Bowie, Byrne, Duffey, Grambs, Grentzer, Harrison, Hebeler, Hornbake, Hovet, Hymes, Kurtz, Leeper, Magoon, Male, Maley, Marx, McClure, Mershon, Morgan, Newell, O'Neill, Perkins, Raths, Risinger, Schindler, Stunkard, Thompson, vanZwoll, Waetjen, Wiggin, Wilson.
Associate Professors: Adkins, J. P. Anderson, Ashlock, Brigham, Bryan, E. G. Campbell, Chambliss, Chapin, Dayton, Dudley, Ehrle, M. H. Gardner, Giblette, Goering, Greenberg, Hall, Hatfield, Henkleman, Huber, James, Kelsey, Kyle, Lawrence, Lemmon, Lindsay, Lockard, Longley, Luetkemeyer, Matteson, Milhollan, Neville, Noll, Ray, Rhoads, Seidman, Simms, Tierney, Walbesser, Weaver, Wedberg, Williams, Woody, Woolf.
Assistant Professors: Agre, Amershek, Beatty, Bolea, D. D. Campbell, Carr, DiLavore, Dittman, Draeger, Duke, Eley, Farrell, Finkelstein, Fischer, Frank, Funaro, A. H. Gardner, Green, Grundig, Gump, Hamby, Herman, Huden, Hunt, Johnson, Larson, Medvene, Moyer, Peters, Peterson, Potterfield, Roderick, Rogolsky, Schramm, Schumacher, Sedlacek, Stipek, Stough, Sullivan, vanNess, Zachary.

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 specialties 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 programs. *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
- Personnel Administration
- Public Relations
- School Facilities
- Supervision of Instruction
- School Finance and Business Management
- Administration in Higher 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

Research Design, Statistics and Measurement

Secondary Education

Special Education
- Emotionally Disturbed
- Gifted
- Mentally Retarded
- Perceptually Impaired

(1) Technical Education

Vocational Education
- Business Education
- (1) Distributive Education
- Home Economics Education
- Vocational Industrial Education

*See Director of Graduate Studies in Education for information about levels.

(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 147. Audio-Visual Education. (3) (Maley, Schramm, 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. (Staff.)

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. (Staff.)

EDUC 150. Educational Measurement. (3)
First and second semesters and summer session. (Staff.)

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. (Staff.)

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. Higher Education
D. Research Design, Statistics, Measurement

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 educa-

tion 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 202. The Junior College. (3) (Kelsey.)

EDUC 203. Problems in Higher Education. (3) (Kelsey.)

EDUC 204. Seminar in Educational Sociology. (2) (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) (Staff.)

EDUC 224. Apprenticeship in Education. (1-9)
A. Adult Education
B. Foundations
C. Higher Education
D. Research Design, Statistics, Measurement

Apprenticeships in the major area of study are available to selected students whose application for an apprenticeship has been approved by the Education faculty. Each apprentice is assigned to work for at least a semester full-time or the equivalent with an appropriate staff member of a cooperating school, school system, or educational institution or agency. The sponsor of the apprentice maintains a close working relationship with the apprentice and the other persons involved. Prerequisites, teaching experience, a master's degree in education, and at least six semester hours in education at the University of Maryland. (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. (Staff.)

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. (Staff.)

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 economic considerations as they relate to current and future mediated instructional systems. (Staff.)

EDUC 237. Curriculum Theory and Research. (2) (Hovet.)

EDUC 241. Problems in the Teaching of Reading. (3)
A. Elementary Schools
B. Secondary Schools

Prerequisite: EDUC 153 or equivalent. Implications of current theory and the results of research for the teaching of reading. Attention is given to all areas of development reading instruction, with special emphasis on persistent problems. (Staff.)

EDUC 245. Introduction to Research. (2)
Intensive reading, analysis, and interpretation of research; applications to teaching fields; the writing of abstracts, research reports, and seminar papers. (Staff.)

EDUC 251. Intermediate Statistics in Education. (3)
Prerequisite, EDUC 151 or equivalent. A study of the basic statistical techniques used for graduate research in education, including tests of significance and sampling techniques. Necessary mathematical skills are developed as part of the course. (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 disabilities and in recommending instructional programs for individual pupils. The second semester deals with instruction of pupils with reading disabilities. Each participant will plan and execute a program of instruction for an individual or a small group, applying findings of the preliminary diagnosis. (Staff.)

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. (Staff.)

EDUC 262. Measurement in Pupil Appraisal. (3)
Prerequisite, EDUC 150. 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 150 and 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 utilized 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. (Dayton, Stunkard.)

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 Research Design, 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)

EDUC 280. Research Methods and Materials. (2)
Research methodology for case studies, surveys, and experiments; measurements and statistical techniques; design, form and style for theses and research reports. Primarily for advanced students and doctoral candidates. (Stunkard.)

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. Higher Education
D. Research Design, Statistics and Measurement

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 nearn no more than three semester hours of credit 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 399. (Dayton, Giblette, Hovet, Johnson, Stunkard.)

EDUC 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.)

EDUC 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 on curriculum and instruction. (Wiggin.)

EDUC 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 Saff.)

EDUC 309. SEMINAR IN PROBLEMS OF HIGHER EDUCATION. (2) (Kelsey.)

EDUC 399. THESIS RESEARCH. (Master's Level)
Registration required to the extent of 6 hours for master's thesis; 6-9 hours for a doctoral project; and 12-18 hours for a doctoral dissertation. (Staff.)

EDUC 499. DISSERTATION RESEARCH. (Doctorate Level) (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 210. The Organization and Administration of Publc 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. (Dudley Newell, van Zwoll.)

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.)

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. (van Zwoll.)

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, Neville, Berman.)

EDAD 217. Administration and Supervision in Elementary Schools. (3)
Problems in administering elementary schools and improving instruction.
(Dudley.)

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. (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. (Neville, V. Anderson, Berman.)

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 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.) (Ehrle, Lawrence.)

EDCP 172. Mental Hygiene in the Classroom. (3)
(Formerly EDUC 162.) (Staff.)

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.

For Graduates

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. (Marx.)

EDCP 224. Apprenticeship in Counseling and Personnel Services. (1-9)
See EDUC 224 for description. (Staff.)

EDCP 240. Psycho-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. (Ehrle.)

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. (Draeger.)

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. (Duke.)

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 behavior 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, Woody.)

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. (Grundig, Woody.)

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 hour 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. (Greenberg.)

EDCP 271. Counseling and Personnel Services Seminar. (2) (Formerly EDUC 269)
Enrollment by permission of instructor. (Stipek, Peterson.)

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. (Staff.)

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. (Ehrle.)

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)
(Staff.)

EARLY CHILDHOOD-ELEMENTARY EDUCATION[1]

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, 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.)

[1] For additional courses in reading see listings under Education.

EDEL 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 developments of each level; study of songs and materials; observation and teaching experience with each age level. (Staff.)

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. (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. (O'Neill, Weaver, Potterfield, 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.
(Hymes, 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, Ashlock.)

EDEL 152. Literature for Children and Young People, Advanced. (3)
Prerequisite, EDUC 052, or approval of instructor.
(Amershek, D. Brown, E. Anderson, Roderick, Zachary.)

EDEL 153. The Teaching of Reading. (2-3)
A. Early Childhood. B. Elementary. C. Secondary.
(Hall, Herman, 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, Staff.)

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, 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. (Hymes.)

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. (Hymes.)

EDEL 214. Intellectual Experiences of the Nursery-Kindergarten Child. (2)
A critical examination of materials, methods and programs in such areas as reading, literature, science, mathematics, the social studies. (Moyer.)

EDEL 215. Creative Experiences of the Nursery-Kindergarten Child. (2)
A critical examination of materials, methods and programs in such areas as art, music, dance and rhythms, language, 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.
(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, Herman, O'Neil, Potterfield, 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.

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 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. (Felker.)

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) (Hymes.)

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 throughout 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.

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, 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 prob-

lems experienced in our society at various maturity levels, and the adjustment mechanisms used to meet them are studied. (Bowie, Goering, Mershon.)

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 overprotection 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 of learning and their impact on education. Considers factors that influence learning.
(Larson, Milhollan, Perkins.)

EDHD 222. Learning Theory and the Educative Process II. (3)
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. (Milhollan, 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 general this training is open only to persons who have passed their preliminary examinations for the doctorate with a major in human development or psychology. (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.

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. An opportunity for advanced students to focus in depth on topics of special interest growing out of their basic courses in human development. (Morgan.)

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.

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.

EDIN 143. Industrial Safety Education I. (2) (Crosby.)

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.)

EDIN 150. Training Aids Development. (3) (Maley.)

EDIN 157. Tests and Measurements. (3)
Prerequisite, EDUC 150 or consent of instructor. (Luetkemeyer.)

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) (Beatty.)

EDIN 167. Problems in Occupational Education. (3) (Chambliss.)

EDIN 169. Occupational Analysis and Course Construction. (3) (Chambliss.)

EDIN 171. History and Principles of Vocational Education. (3) (Luetkemeyer.)

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.

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 Distributivl Education. (3) (Anderson.)

EDSE 123. Fifld 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)
Prerequisites, EDSE 140. (Lemmon.)

EDSE 126. Evaluation of Home Economics. (3) (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's 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. (Huguenard.)

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)
The study and evaluation of the literature and research in Business Education. (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. 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.

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

An opportunity to pursue special subject area interests in curriculum construction, course of study development, or other teaching problems. Class members may work on problems related directly to their own school situations. (Staff.)

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 curriculum research and organization of appropriate course content. (Peters.)

EDSE 260. Seminar in Home Economics Education. (2) (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. (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 125. Creative Activities in the Elementary School. (2-3)
Prerequisite, MUSC 016 or consent of instructor. A study of the creative approach to singing, listening, playing, rhythmic activity, and composition. These topics are studied in correlation with other areas and creative programs. (Shelley.)

EDMU 128. Music for Elementary Classroom Teacher. (2-3)
Prerequisite, MUSC 016 or consent of instructor. (Blum, Shelley.)

EDMU 132. Music in the Secondary School. (2-3)
Prerequisite, consent of instructor. (Eisenstadt.)

EDMU 139. Music for the Elementary School Specialist. (2-3)
Prerequisite, senior standing. A survey of instructional materials; objectives; organization of subject matter; lesson planning; methods and procedures in singing, listening, rhythms, simple instruments and creative activities for the music specialist in the elementary school. Twenty periods of observation will be required for three credits. (Blum.)

EDMU 163. Band Techniques and Administration. (2-3)
Prerequisites, MUSC 081 and 161. Two lectures and two laboratory hours per week. Intensive study of a secondary wind instrument and of rehearsal techniques. A survey of instructional materials, administrative procedures, and band pageantry will be included. (Staff)

EDMU 170. Methods and Materials for Class Piano Instruction. (2)
The study of the principles and techniques of teaching class piano. The following groups, beginning and advanced, will be used for demonstrations:

elementary school children, junior and senior high school students, adults. Special emphasis will be placed on the analysis of materials. (de Vermond.)

EDMU 173. The Vocal Music Teacher and School Organization. (2)
Prerequisite, practice teaching or teaching experience. Study of the function of the vocal music teacher in the elementary and secondary schools. Students will serve as resource teachers for those enrolled in EDMU 139. Open to graduate students by permission of instructor. (Blum.)

EDMU 175. Methods and Materials in Vocal Music for the High School. (2-4)
Prerequisite, consent of instructor. A survey of suitable vocal and choral repertoire for the high school. Problems of diction interpretation, tone production, and phrasing. The course is designed primarily for choral directors and teachers of voice classes. (Shelley, Grentzer.)

EDMU 176. Special Problems in the Teaching of Instrumental Music. (2-6)
Prerequisite, MUSC 061 through 067 or equivalent. Advanced studies in the teaching of orchestral instruments through performance. Review of literature and teaching materials. The course may be taken three times since the subject matter dealing with the several categories of instruments (string, woodwind, brass-percussion) will be offered on a rotating basis. (Staff.)

EDMU 180. Instrumental Music for the High School. (2)
Prerequisite, consent of instructor. A survey of the repertoires for high school orchestra, band, and small ensemble. Problems of interpretations, 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 204. Current Trends in Music Education. (3)
A survey of current philosophies and objectives of music in the schools. The scope and sequence of the music curricula, vocal and instrumental, on the elementary schools. A study of the music curriculum as a part of the total school

EDMU 205. Vocal Music in the Elementary Schools. (3)
A comparative analysis of current methods and materials used in the elementary schools. A study of the music curriculum as a part of the total school program, and of the roles of the classroom teacher and the music specialist. (Blum, Grentzer.)

EDMU 206. Choral Conducting and Repertoire. (3)
The study and reading of choral literature of all periods, including the contemporary, suitable for use in school and community choruses. Style, interpretation, tone quality, diction, rehearsal and conducting techniques are analyzed. (Traver.)

EDMU 207. Vocal Music in the Secondary Schools. (3)
A comparative analysis of current methods and materials used in teaching

junior and senior high-school classes in general music, history and appreciation, theory, and voice; and in directing choral groups and community singing. (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. Seminar in Instrumental Music. (2)
A consideration of acoustical properties and basic techniques of the instruments. Problems of ensemble and balance, intonation, precision, and interpretation are studied. Materials and musical literature for orchestras, bands and small ensembles are evaluated. (Staff.)

EDMU 210. Advanced Orchestration and Band Arranging. (Seminar). (2)
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 and Aesthetics of Music Education. (3)
Prerequisite, permission of instructor. The study of the development of pedagogical practice in music education, their aesthetic implications and educational values. (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.
(Seidman, Jacobs, D. D. Campbell ,Simms.)

EDSP 171. Characteristics of Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. C. Perceptually impaired. Prerequisite, EDSP 170. (D. D. Campbell, Simms, Jacobs.)

EDSP 172. Education of Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. C. Perceptually impaired. Prerequisite, EDSP 171 or equivalent. (D. D. Campbell, Simms, Jacobs.)

EDSP 173. Curriculum for Exceptional Children. (3)
A. Mentally Retarded. B. Gifted. Prerequisite, EDSP 171 or equivalent. (D. D. Campbell, Simms.)

EDSP 175. Education of the Slow Learner. (3) (Seidman.)

EDSP 187. Field Experience in Education. (1-4)
See EDUC 187 for description.

EDSP 188. Special Problems in Education. (1-3)
See EDUC 188 for description.

EDSP 189. Workshops, Clinics, Institutes. (1-6)
See EDUC 189 for description.

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. (Seidman.)

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. (Huber.)

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. (Campbell, Seidman.)

EDSP 210. Administration and Supervision of Special Education Programs. (3)
Prerequisite, consent of instructor. Consideration of the determination, establishment and function of educational programs for exceptional children for administrative and supervisory personnel. (Hebeler.)

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. (D. D. Campbell, Simms.)

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. (D. D. Campbell, Simms.)

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. (Huber.)

EDSP 224. Apprenticeship in Education. (1-9)
See EDUC 224 for description.

EDSP 225. Problems in the Education of the Mentally Retarded. (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, regarding the mentally retarded. (Simms.)

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. (Hebeler, Simms.)

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, regarding the emotionally disturbed. (Huber.)

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. (Campbell.)

EDSP 278. Seminar in Special Education. (2)
Prerequisite, 9 hours in EDSP, or consent of instructor. An overview of education of exceptional children. (Hebeler.)

EDSP 287. Internship in Education. (3-16)
See EDUC 287 for description.

EDSP 288. Special Problems in Education. (1-6)
See EDUC 288 for description.

EDSP 399. Thesis Research. (Master's Level)
See EDUC 399 for description.

EDSP 499. Dissertation Research. (Doctoral Level)

ELECTRICAL ENGINEERING

Professors: DeClaris, Chu, Price, Rutelli, Wagner, and Weiss.
Research Professor: Jones.*
Associate Professors: Basham, Ginnings, Harger, Hochuli, Marcovitz, Pugsley, Rao, Reiser, Taylor, and Simons.
Research Associate: Abraham
Assistant Professors: Abrams, Emad, Friedman, Jess, Kim, Larson, Lee, LeVine, Lieberman, Rumbaugh, and Tretter.
Visiting Assistant Professor: Siahatgar.
Lecturers: Degenford, Lin, Morakis, Schulman, Whicker.
Instructors: Colburn, Glock, Guha, and Jones.

Attractive research opportunities for individual investigations and thesis work, essential to any graduate program in Electrical Engineering are available in:

1. *ELECTROPHYSICS*
   a. Electromagnetic Fields
   b. Electron and Ion Beam Dynamics
   c. Quantum Electronics
   d. Plasmas
   e. Semiconductors
   f. Atmospheric Physics

2. *ELECTROTECHNOLOGY*
   a. Antennae
   b. Ion Guns; Particle Accelerators
   c. Lasers
   d. Electronic and Solid State Circuits
   e. Computer-Aided Design
   f. Computer Technology
   g. Biomedical Electronics

* Member of the Institute for Fluid Dynamics and Applied Mathematics.

3. *SYSTEM SCIENCE*
   a. General System Theory
   b. Control Systems
   c. Communication Systems
   d. Information Processing Systems
   e. Discrete-Time Systems
   f. Simulation

The Electrical Engineering Department offers programs leading to the degrees of Master of Science and of Doctor of Philosophy, and it directs the studies of the graduate students who plan to qualify for the degrees.

Basic requirements for the M.S. and the Ph.D. degrees are set forth on pages 27 and 33 of this catalog. Departmental regulations concerning qualifying and comprehensive examinations as well as course work have been assembled for the guidance of graduate students. Copies of the regulations, and/or further information, may be obtained in person from, or by writing to, the "Office of Graduate Studies, Department of Electrical Engineering."

The Department offers courses at convenient times and places as to accommodate the greatest number of students. However, all M.S. candidates must take at least six credits of course work in Electrical Engineering on the College Park campus.

ELECTROMAGNETICS AND PHYSICAL ELECTRONICS

For Graduates and Advanced Undergraduates

ENEE 130,* 132.* Engineering Electromagnetics I, II. (3, 3)
Three hours of lecture per week. Prerequisites, MATH 022, PHYS 021, and ENEE 090, with an average grade in MATH 021-022, PHYS 020-021 and ENEE 090 of C or better. Required of juniors in electrical engineering. Electric and magnetic fields, using vector notation; Maxwell's equations; Lorentz force law; capacitance, inductance, and resistance; motion of charged particles; fields in material media, polarization, magnetization; boundary value problems. The study of electromagnetism is continued in ENEE 134. (Taylor.)

ENEE 134.* Engineering Electromagnetics III. (3)
Three hours of lecture per week. Prerequisite, ENEE 132. Required of seniors in electrical engineering. Continuation of ENEE 132. The wave equation and the impedance concept; plane waves; reflection and refraction; wave guides and transmission lines; Smith charts, lumped models. (Hochuli.)

ENEE 135.* Electromagnetic Measurements Laboratory. (1)
Two hours of laboratory per week. Corequisite, 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 140.* Transducers and Electrical Machinery. (3)
Three hours of lecture per week. (See ENEE 141 for related laboratory course.) Prerequisites, ENEE 120, ENEE 132. Corequisite, ENEE 141. Required of seniors in electrical engineering. Electromechanical transducers; theory of electromechanical systems; power and wide-band transformers; rotating electrical machinery from the theoretical and performance points of view. (Rumbaugh.)

ENEE 141.* Transducers and Electrical Machinery Laboratory. (1)
Two hours of laboratory per week. Corequisite, ENEE 140. Required of seniors

* Graduate Credit not given to E. E. Majors for these courses.

in electrical engineering. Laboratory to be taken in association with ENEE 140. Experiments on transformers; synchronous machines; induction motors; synchros; loudspeakers; other transducers. (Rumbaugh.)

ENEE 170. Antennas and Wave Propagation. (3)
Three hours of lecture per week. Corequisite, ENEE 134. Review of Maxwell's equations; radiation; antennas; radio wave propagation. (Taylor.)

ENEE 182. Introduction to Semiconductor Physical Electronics. (3)
Three hours of lecture per week. Prerequisites, ENEE 132 and PHYS 153, or equivalent. Basic properties of semiconductors; idealized p-n junction and transistor theory; d-c parameters; low-frequency characteristics; frequency response; high-frequency characteristics; transistors as amplifiers and as switches; field effect transistors; integrated circuit considerations; other junction devices. (Kim.)

ENEE 184. Physical Electronics of Vacuum and Gaseous Devices. (3)
Three hours of lecture per week. Prerequisites, ENEE 132 and PHYS 153, or equivalents. Essential principles of quantum mechanics and quantum statistics; electron emission; electrons in electric and magnetic fields; space charge effects; vacuum tubes; electron beams; gas discharges and plasmas in electronic devices. (Reiser.)

ENEE 186. Particle Accelerators, Physical and Engineering Principles. (3)
Three hours of lecture per week. Prerequisites, ENEE 132 and PHYS 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. (Reiser.)

For Graduates

ENEE 201. Electromagnetic Theory. (3)
Two lectures per week. Prerequisites, ENEE 134 or 170 or 215, or equivalent. Theoretical analysis and engineering applications of Laplace's, Poisson's, and Maxwell's equations. (Hochuli.)

ENEE 206, 207. Microwave Engineering. (3, 3)
Two lectures, or one lecture and one laboratory, per week. Prerequisite, ENEE 201 or ENEE 216. Basic considerations in solving field problems using differential equations; circuit concepts and their validity at high frequency; guided electromagnetic waves; principles of masers and lasers; propagation and diffraction, including the optical region. Fundamental experiments at microwave and optical frequencies. (Hochuli.)

ENEE 215, 216. Radio Wave Propagation. (3, 3)
Two lectures per week. Prerequisite, undergraduate degree in electrical engineering, physics, or mathematics. Maxwell's wave equation; concept of retarded magnetic vector potential; propagation over plane earth; propagation over spherical earth; refraction; meteorological effects; complex antennas; air-to-air propogation; lobe modulation. (Taylor.)

ENEE 245. Electrical Techniques in Medicine and Biology. (3)
Two lectures per week. Prerequisite, mathematics through differential equations and physics through electricity and magnetism, or equivalent. Electrical properties of biological tissues and cell suspensions; alternating-current impedance spectroscopy; transducers and related instrumentation systems for biological measurements; biological control systems; interaction of electromagnetic fields with biological systems. (Ferris.)

ENEE 250. Mathematics for Electromagnetism. (3)
Two lectures per week. Prerequisite, undergraduate preparation in electromagnetic theory and advanced calculus. Tensors and curvilinear coordinates; partial

differential equations of electrostatics and electrodynamics; functionals, integral equations, and calculus of variations as applied to electromagnetism. (Rutelli.)

ENEE 251. Antenna Theory. (3)
Two lectures per week. Prerequisite, ENEE 250 or equivalent. Review of Maxwell's equations; radiative networks; linear antennas; antenna arrays; aperture antennas; slot antennas; advanced topics. (Rutelli.)

ENEE 280. Electronic Properties of Semiconductors. (3)
Three hours per week. Prerequisite, ENEE 182, or MATH 066 and PHYS 053, or equivalents. 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. (Lee.)

ENEE 282. Technology of Semiconductor Devices and Materials. (3)
Three hours per week. Prerequisites, ENEE 182 or PHYS 053 or ENEE 290. Basic processes involved in the fabrication of transistors and other semiconductor devices; crystal growth and epitaxy; crystal orientation; purification and doping of crystals; diffusion; electrical and optical properties; photo-resist techniques; oxide passivation; contacts; device assembly and packaging. Emphasis is on silicon but other materials of engineering significance are considered. (Lin.)

ENEE 290. Charged Particle Dynamics, Electron and Ion Beams. (3)
Three hours per week. Prerequisite, consent of the instructor. General principles of single-particle dynamics; mapping of electric and magnetic fields; equation of motion and methods of solution; production and control of charged particle beams; electron optics; Liouville's theorem; space charge effects in high current beams; design principles of special electron and ion beam devices. (Reiser.)

CIRCUITS AND CONTROL SYSTEMS

For Graduates and Advanced Undergraduates

ENEE 120.* Circuit Analysis II. (4)
Four hours of lecture per week. (See ENEE 121 for related laboratory course.) Prerequisite, ENEE 090. Corequisites, ENEE 121, MATH 066. Required of juniors in electrical engineering. Continuation of ENEE 090. Complex frequency and frequency response; application of both frequency domain and time domain concepts; mutual inductance and transformers; polyphase concept, Fourier and Laplace transform methods; driving point and transfer functions; controlled sources. (Basham.)

ENEE 121.* Circuit Laboratory II. (1)
Two hours of laboratory per week. Corequisite, 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. (Pugsley.)

ENEE 122.* Electronic Circuits. I. (4)
Four hours of lecture per week. (See ENEE 123 for related laboratory course.) Prerequisite, ENEE 120. Corequisites, 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 wideband amplifiers, feedback. ENEE 124 continues where ENEE 122 ends. (Simons.)

ENEE 123.* Electronics Laboratory I. (1)
Two hours of laboratory per week. Corequisite, ENEE 122. Required of juniors

* Graduate Credit not given to E. E. Majors for these courses.

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. (Simons.)

ENEE 124.* Electronic Circuit II. (4)
Four hours of lecture per week. (See ENEE 125 for related laboratory course.) Prerequisite, ENEE 122. Corequisites, 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 circuits; modulation and detection; pulse generation, delay, and storage; feedback amplifiers. (Simons.)

ENEE 125.* Electronics Laboratory II. (1)
Two hours of laboratory per week. Corequisite, 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. (Simons.)

ENEE 144. Electronic Circuits. (3)
Three hours of lecture per week. 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. (Simons.)

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 for 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. (Ferris.)

ENEE 148. Electronic Instrumentation for Physical Science. (3)
Two hours of lecture and two hours of laboratory per week. Prerequisite, ENEE 060 or 120. PHYS 104 or equivalent, or consent of the instructor. The concept of instrumentation systems from sensor to readout; discussion of transducers; system dynamics, precision, and accuracy; measurement of electrical parameters; direct, differential, and potentiometric measurements; bridge measurements; time and frequency measurements; wave-form generation and display. (Ferris.)

ENEE 150. Network Synthesis. (3)
Three hours of lecture per week. Prerequisite, ENEE 120. Positive real functions; synthesis of driving point impedances; network functions; approximation methods; Chebychev and Butterworth filters. (Basham.)

ENEE 154. Feedback Control Systems. (3)
Three hours of lecture per week. Prerequisite, MATH 066 and ENEE 122. (See ENEE 155 for related laboratory course.) Feedback system operation and design; stability criteria; basic design techniques; correlation of time and fre-

* Graduate Credit not given to E. E. Majors for these courses.

quency domain concepts; flow graph algebra; system synthesis to a variety of specifications. (Emad.)

ENEE 155. Feedback Control Systems Laboratory. (1)
Two hours of laboratory per week. Corequisite, 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. (Emad.)

ENEE 172. Advanced Pulse Techniques. (3)
Three hours of lecture per week. (See ENEE 173 for related laboratory course.) Prerequisite, ENEE 124 or ENEE 146 or equivalent. Bistable, monstable, and astable circuits; sweep circuits; synchronization; counting; gates; comparators; magnetic core circuits; semiconductor and vacuum tube circuits. (Schulman.)

ENEE 173. Pulse Techniques Laboratory. (1)
Two hours of laboratory per wek. Corequisite, ENEE 172 or ENEE 164 and permission of the instructor. Experiments on switching circuits; bistable, monstable, and astable circuits; sweep circuits; gates; comparators. (Simons.)

ENEE 174. Advanced Radio Engineering. (3)
Three hours of lecture per week. Corequisite, 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. (Wagner.)

ENEE 175. Advanced Radio Engineering Laboratory. (1)
Two hours of laboratory per week. Corequisite, ENEE 174. Experiments on multiple tuned amplifiers, noise figure measurements; class-C amplifiers; varactors; oscillators; modulators, Projects. (Friedman.)

ENEE 190. Mathematical Foundations of Circuit Theory. (3)
Three hours of lecture per week. Prerequisite, ENEE 120 and MATH 022, or equivalent. This course is intended primarily for students preparing for graduate study. Review of determinants; linear equations; matrix theory; eigenvalues; theory of complex variables; inverse Laplace transforms. Applications are drawn primarily from circuit analysis. (Marcovitz.)

For Graduates

ENEE 202, 203. Transients in Linear Systems. (3, 3)
Two lectures per week. 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 204. Advanced Electronic Circuit Design. (3)
Two lectures per week. Prerequisite, ENEE 124 or consent of the instructor. Comparison of bipolar and field effect transistors; detailed frequency response of single and multistage amplifier; design of feedback amplifiers; d-c coupling techniques; design of multistage tuned amplifiers. (Simons.)

ENEE 212, 213. Servomechanism. (3, 3)
Two lectures per week. Prerequisites, ENEE 154 and ENEE 202, or equivalent. Linear control systems with deterministic and stochastic inputs; nonlinear control systems; time and frequency domain techniques. (Price.)

ENEE 230. Mathematics of Circuit Analysis. (3)
Two lectures per week. Prerequisite, undergraduate circuit theory and advanced calculus. Determinants; linear equations; matrix theory; eigenvalues; theory of

complex variables; inverse Laplace transforms; applications to circuit analysis. (Marcovitz.)

ENEE 232, 233. Network Synthesis. (3, 3)
Two lectures per week. Design of driving-point and transfer impedance functions with emphasis on the transfer loss and phase of minimum-phase networks; flow diagrams; physical network characteristics, including relations existing between the real and imaginary components of network functions; modern methods of network synthesis. (Basham.)

ENEE 234. Graph Theory in Network Analysis. (3)
Two lectures per week. 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. (Wagner.)

ENEE 235. Applications of Tensor Analysis. (3)
Two lectures per week. 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 238. Sampled Data Control Systems. (3)
Two lectures per week. Prerequisite, undergraduate or graduate preparation in linear feedback control theory. Z-transform and modified Z-transform method of analysis; root locus and frequency response method of analysis; discrete and continuous compensation; analysis with finite pulse width; digital control systems. (Price.)

ENEE 280. Electronic Properties of Semiconductors. (3)
Three hours per week. Prerequisite, ENEE 182, or MATH 066 and PHYS 153, or equivalents. 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. (Lee.)

ENEE 282. Technology of Semiconductor Devices and Materials. (3)
Three hours per week. Prerequisite, ENEE 182 of PHYS 153 or ENEE 290. Basic processes involved in the fabrication of transistors and other semiconductor devices; crystal growth and epitaxy; crystal orientation; purification and doping of crystals; diffusion; electrical and optical properties; photo-resist techniques; oxide passivation; contacts; device assembly and packaging. Emphasis is on silicon but other materials of engineering significance are considered. (Lin.)

ENEE 284. Semiconductor Device Models. (3)
Two lectures per week. Prerequisite, ENEE 182 and ENEE 234, or equivalents. Single-frequency models for transistors; small-signal and wide-band models for general non-reciprocal devices; hybrid-pi and tee models for transistors; relationship of models to transistor physics; synthesis of wide-band models from terminal behavior; computer utilization of models; models for other semiconductor devices. (Lin.)

INFORMATION SCIENCES

For Graduates and Advanced Undergraduates

ENEE 142.* Engineering Probability. (2)
Two hours lecture per week. Prerequisites, MATH 022, ENEE 090. Required

*Graduate Credit not given to E. E. Majors for these Courses.

of electrical engineering majors. Probability theory, discrete and continuous; statistical distribution functions and their parameters; applications to electrical engineering. (Ginnings.)

ENEE 158. Signal Analysis, Modulation, and Noise. (3)
Three hours of lecture per week. Prerequisite, ENEE 122, ENEE 142. Signal transmission through networks; transmission in the presence of noise; statistical methods of determining error rate and transmission effects; modulation schemes. (Tretter.)

ENEE 160. Analog and Hybrid Computers. (3)
Three hours of lecture per week. Prerequisite, ENEE 122. Programming the analog computer; analog computing components; error analysis, repetitive operation; synthesis of systems using the computer; hybrid computer systems. (Chu.)

ENEE 162. Logic of Digital Computers. (3)
Two hours of lecture and two hours of laboratory per week. Prerequisites, MATH 021, ENEE 080, or equivalent. Symbolic logic and Boolean Algebra; switching circuits; simplification; binary and other number representations and codes; storage elements defined logically; basic sequential circuits; digital systems. (Pugsley.)

ENEE 164. Digital Computer Technology. (3)
Three lectures per week. (See ENEE 173 for related laboratory.) Prerequisites, ENEE 122, ENEE 162. Organization of electronic digital computers; electronic subassemblies; integrated circuits; digital storage; digital and analog magnetic recording; analog-digital conversion. (Rao.)

For Graduates

ENEE 218, 219. Signal Analysis and Noise. (3,)
Two lectures per week. Prerequisite, equivalent to ENEE 158. Mathematical description of noise; spectral analysis; noisy signal detection; optimum linear systems. (Ginnings.)

ENEE 220. Statistical Communication Theory. (3)
Two lectures per week. Prerequisite, ENEE 219. Statistical description of signals; testing statistical hypotheses; likelihood testing; statistical estimation of signal parameters. (Tretter.)

ENEE 221. Information Theory. (3)
Two lectures per week. Prerequisite, MATH 133 or equivalent. Information measure; channels; source encoding; error correcting codes. (Morakis.)

ENEE 262. Combinatorial Switching Theory. (3)
Two lectures per week. Prerequisite, ENEE 162 or consent of instructor. Applications of Boolean algebra to combinational switching circuits; symmetric functions; majority and threshold networks; function decomposition; minimization; prime implicants and algorithms for finding them; minimal and nearly minimal covers. (Pugsley.)

ENEE 263. Theory of Sequential Machines. (3)
Two lectures per week. Prerequisite, ENEE 262 or consent of instructor. Models for sequential machines; equivalence; state minimization; incompletely specified machines; linear sequential machines; regular expressions, partitions, and state assignment. (Pugsley.)

ENEE 270. Digital Computer Design. (3)
Two lectures per week. Prerequisite, ENEE 162 or equivalent. Introduction to

design techniques for digital computers; review of Boolean algebra; digital arithmetic; logic circuits; digital memories; design of computer elements, arithmetic unit, and control unit. A simple digital computer will actually be designed during the course. (Chu.)

ENEE 272. Advanced Digital Computer Design. (3)
Two lectures per week. Prerequisites, ENEE 270 or equivalent; knowledge of computer programming. Computer design languages; computer organization; computer design by language translation; integrated logic circuit design; digital memories including read-only and associative memories; case studies of computer designs. (Chu.)

ENEE 274. Digital Systems Engineering. (3)
Two lectures per week. Prerequisite, ENEE 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. (Pugsley.)

ENEE 276. Computers for Differential Equation Solution. (3)
Two lectures per week. Prerequisite, ENEE 162, knowledge of elementary differential equations, numerical methods, and programming. Mechanistic methods for differential equation solution; application of analog or hybrid computers for the purpose; digital differential analyzers; digital-analog simulation on a general-purpose digital computer. MIMIC Language and examples of its use. Class will run simulation program on an IBM 7094 or similar computer. (Chu.)

RESEARCH, SEMINARS, AND SPECIAL TOPICS

For Graduates and Advanced Undergraduates

ENEE 180. Topics in Electrical Engineering. (3)
Prerequisite, permission of the instructor. May be taken for repeated credit up to a total of 6 credits, with the permission of the student's advisor and the instructor. Selected topics from the literature of modern electrical engineering. (De Claris.)

For Graduates

ENEE 222. Graduate Seminar. (1-3)
Prerequisite, consent of instructor. Seminars held on topics of current interest in Electrophysics, Electrotechnology and System Science. May be taken for repeated credit. (Basham.)

ENEE 223. Advanced Topics in Electrical Engineering. (3)
Prerequisite, permission of the instructor. Selected topics from recent contributions in electrical engineering. May be taken for repeated credit. (DeClaris.)

ENEE 399. Thesis Electrical Engineering Research. (Master's Level)
Prerequisite, consent of thesis supervisor. Six semester hours of credit in ENEE 399 are required of M. S. degree candidates. A thesis covering an approved research problem and written in conformity with the regulations of the Graduate School is a partial requirement for either the degree of Master of Science or the degree of Doctor of Philosophy in electrical engineering. (DeClaris.)

ENEE 499. Dissertation Electrical Engineering Research. (Doctoral Level) (DeClaris.)

ENGLISH LANGUAGE AND LITERATURE

Professors: Freedman, Bode, Cooley, Harman (*Emerita*), Hovey, Korg, McManaway (P.T.), *MANNING*, Mish, Murphy, Myers, Panichas, Whittemore, and Zeeveld.

Associate Professors: Barnes, Brown, Bryer, Cooper, Fleming, Gravely, Herman, Houppert, Jellema, Kinnaird, Lawson, Lutwack, Pitts, Portz, D. Smith, G. Smith, Thorberg, Ward, and Weber.

Assistant Professors: Birdsall, Carey, Cate, Coulter, Holton, Howard, Kenney, Kleine, Lounsbury, Martin, Robb, Spurgeon, Van Egmond, Vitzthum, Walt, and Wilson.

The Department of English offers graduate work leading to the degrees of Master of Arts and Doctor of Philosophy. Candidates normally take both major and minor work within the Department of English, but with permission students may take minor work in other departments.

Departmental requirements for the degree of Master of Arts include: (1) ENG 201; (2) three credits from the following: ENG 102, 105, 107, 108, 229; (3) six credits in the English 230 series. Candidates must meet a foreign language requirement by either (1) passing a Graduate School reading examination in French or German; or (2) submitting a record of twelve 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, usually satisfied by a reading knowledge of French and German; (2) ENGL 102 and 202; (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 M.A. 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) (Robb.)

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) (Beauchamp, 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, Weber.)

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) (Howard, Myers, Saltz.)

ENGL 129, 130. Literature of the Romantic Period. (3, 3) (Kinnaird, G. Smith, Weber.)

ENGL 134, 135. Literature of the Victorian Period. (3, 3) (Brown, Cate, Korg, Pitts.)

ENGL 139, 140. The English Novel. (3, 3) (Kenney, Korg, Ward.)

ENGL 141. Major British Writers. (3)

ENGL 142. Major British Writers. (3)

ENGL 143. Modern Poetry. (3) (Fleming, Jellema.)

ENGL 144. Modern Drama. (3) (Bryer, Freedman, Weber.)

ENGL 145. The Modern Novel. (3) (Holton, Lawson, Panichas.)

ENGL 146. American Drama. (3) (Bryer.)

ENGL 148. The Literature of American Democracy. (3) (Barnes.)

ENGL 149. American Literature to 1810. (3) (Barnes, Vitzthum.)

ENGL 150. American Literature, 1810-1865. (3) (Bryer, Carey, Gravely, Hovey, Johnson, Lawson, Reed, Thorberg, Van Egmond, Vitzthum.)

ENGL 151. American Literature Since 1865. (3) (Bryer, Carey, Hovey, Johnson, Lawson, Reed, Thorberg, Van Egmond.)

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, Portz.)

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 170. Creative Writing. (3) (Fleming, Jellema.)

ENGL 171. Advanced Creative Writing. (3) (Fleming, Jellema.)

ENGL 172. Playwriting. (3) (Fleming.)

ENGL 190, 191. Honors Conference and Reading. (1, 1) (Weber.)

ENGL 199. Senior Proseminar in Literature. (3) (Portz.)

ENGL 201. Bibliography and Methods. (3)
(Bryer, Cooper, Hovey, Mish, D. Smith.)

ENGL 202. Middle English. (3) (S. Holton.)

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)
(Freedman, Mish.)

ENGL 212, 213. Seminar in Eighteenth Century Literature. (3, 3)
(Myers, Wilson.)

ENGL 214, 215. Seminar in Nineteenth Century Literature. (3, 3)
(Brown, Kinnaird, Korg, 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 230. Special Studies in English Literature, to 1600. (3)
(Cooley, Cooper.)

ENGL 232. Special Studies in English Literature, 1600-1800. (3) (Murphy.)

ENGL 235. Special Studies in Nineteenth Century English Literature. (3)
(Kinnaird.)

ENGL 237. Special Studies in American Literature. (3) (Lutwack.)

ENGL 241. 242. Studies in Twentieth Century Literature. (3, 3)
(Bode, Hovey, Lawson, Panichas.)

ENGL 244. Studies in Drama. (3 (Freedman.)

ENGL 245. Studies in Fiction. (3) (Mish.)

ENGL 257. Seminar in Folklore. (3) (Carey.)

ENGL 399. Thesis Research. (1-6) (Master's Level.) (Staff.)

ENGL 499. Dissertation Research. (Doctoral Level.) (1-6) (Staff.)

ENTOMOLOGY

Professors: Bickley, Cory (*Emeritus*), Jones, and Langford.
Associate Professors: Harrison, and Messersmith.
Assistant Professors: Davidson, Haviland (*Emeritus*), and Menzer.
Lecturer: Heimpel.

The Department of Entomology offers work toward the degrees of Master of Science and Doctor of Philosophy. Candidates for the Ph.D. degree who are not employed by the Department are expected to register for a minimum of 24 semester hours credit during two semesters at College Park.

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. The theory and practice of apiary management. Designed for the student who wishes to keep bees or requires a practical knowledge of bee management. (Staff.)

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 arthropodal 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 116. Insect Pests of Ornamentals and Greenhouse Plants. (3)
Second semester. Two lectures and one two-hour laboratory period a week. Prerequisite, BOTN 001 and ZOOL 001. (Davidson.)

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 198. Special Problems. (1-3)
First and second semester. 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. (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: Davis, Arbuckle, and Keeney (Dairy Science).
Stark,* Kramer, and Scott (Horticulture).
Shaffner (Poultry Science).
Foster (Animal Science).
Associate Professors: King and Mattick (Dairy Science).
Wiley (Horticulture).
Helbacka (Poultry Science).
Buric (Animal Science).

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 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. Prerequisite, CHEM 033. (King)

FDSC 112. Analytical Quality Control. (3)
Second semester. Two lectures and one laboratory a week. Prerequisite, CHEM 033. 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. (Offered 1969-70). Two lectures and one laboratory a week. Prerequisite, CHEM 161 or permission of instructor.

FDSC 131. Food Product Research and Development. (3)
Second semester. Two lectures, one laboratory a week. Prerequisite, FDSC 103, CHEM 163 or permission of instructor. (Mattick and Staff)

* Chairman of Curriculum Committee.

FDSC 156. Horticultural Products Processing. (3)
Second semester, alternate years. (Offered 1968-69). Two lectures and one laboratory a week. (Wiley)

FDSC 160. Technology of Market Eggs and Poultry. (3)
First semester, alternate years. (Offered 1969-70). Two lectures and one laboratory a week. (Helbacka)

FDSC 175. Seafood Products Processing. (3)
Second semester, alternate years. (Offered 1969-70). Two lectures and one laboratory a week. Prerequisite, CHEM 163 or permission of instructor. (Tatro)

FDSC 182. Dairy Products Processing. (3)
First semester, alternate years. (Offered 1968-69). 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. (Offered 1968-69). Prerequisite, CHEM 161 or permission of instructor. (Kramer.)

FDSC 301. Special Problems in Food Science. (1 to 4)
First and second semester. 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. (Staff)

FDSC 302. Seminar in Food Science. (3)
First or second semesters. Prerequisite, CHEM 163. 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

(Staff)

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. (Master's Level)
First and second semesters; summer session. The investigation is planned and conducted under faculty supervision. Grades are awarded on completion of the thesis.

FDSC 499. Dissertation Research. (Doctoral Level)

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 LANGUAGE AND LITERATURE

Professors: MacBain (*Head*), Bingham, Falls (*Emeritus*), Quynn, and Rosenfield.
Associate Professors: Demaitre, and Hall.
Assistant Professors: Fink, Lamarque, and Zimmerman.
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 establshed by the Departmen. 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 M.A. 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 comprehensive examination at least one year before the degree is awarded. The examination will include linguistics.

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. (Staff.)

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 major to understand literature in depth and make mature esthetic evaluations of it. (Lamarque.)

FREN 107. Introduction to Medieval Literature. (3)
French History from the ninth through the fifteenth century. Selected readings from representative texts. (Lamarque.)

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 Moliere. (Quynn.)

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. (Zimmerman.)

FREN 141-142. French Literature of the Twentieth Century. (3, 3)
First and second semesters. First semester: drama and poetry from Symbolism to the present time. Second semester: the contemporary novel. (Demaitre.)

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.)

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. Prerequisite, some knowledge of Latin desirable. (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 literature. (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. (MacBain.)

FREN 210. Elementary Old Provencal. (3)
The essentials of Old Provencal phonology and morphology necessary to reading; readings in Old Provencal lyric poetry and other representative literary works. Prerequisite, some knowledge of Latin desirable. (MacBain.)

FREN 213-214. Seminar in French Renaissance. (3, 3) (Staff.)

FREN 215-216. Seminar in Moliere. (3, 3) (Quynn.)

FREN 218-219. Seminar in French Classicism. (3, 3) (Quynn.)

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. (Demaitre.)

FREN 251-252. The History of Ideas in France. (3, 3)
Analysis of currents of ideas as reflected in French literature. First semester, 17th and 18th centuries. Second semester, 19th and 20th centuries. Conducted in English. (Rosenfield.)

FREN 261-262. Seminar in a Great Literary Figure. (3, 3)9 (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 and doctoral theses. Conferences. (Staff.)

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

GEOGRAPHY

Professors: Ahnert, Deshler, Harper, and Hu.
Associate Professors: Chaves, and Fonaroff.
Assistant Professors: Brodsky, Lewis, and Wiedel.

Applicants for admission to graduate work in geography should furnish graduate record examination scores and, in the case of Ph.D. candidates and all stu-

dents 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 written comprehensive examination, taken after completion of all course work but before the final oral examination, is required of all Master's candidates.

Master's degree candidates are required to show competency in reading a foreign language approved by the department. Ph.D. 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 Ph.D. 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 Ph.D. 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. (Kinerney)

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 principles (Staff.)

GEOG 105. Geography of Maryland and Adjacent Areas. (3) (Staff.)

GEOG 109. Introduction to Geographic Research. (3)
Development of research methods in geography including the formulation of problem, 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.

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.

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.

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 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. (Staff.)

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.)

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 geographic distribution of certain major crops and animals in relation to the physical environment and economic geographic conditions. Main problems of conservation. (Staff.)

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. (Holmes.)

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. (Volk.)

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 areas 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. (Hu.)

GEOG 190. Political Geography. (3) (Chaves.)

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. (Staff.)

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. (Staff.)

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.)

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 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 cultural 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. (Staff.)

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. (Staff.)

GEOG 246. Seminar in the Geography of the Near East. (3)
First and second semesters.

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. (Staff.)

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. (Staff.)

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. (Staff.)

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 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, and Zucker (*Emeritus*).
Visiting Professor: Hansel.
Assistant Professors: Hitchcock, Knoche, and Morris.

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 Eighteenth Century. (3, 3)
First and second semesters. The main works of Klopstock, Wieland, Lessing, Herder, Goethe, Schiller. (Prahl, Knoche.)

GERM 131-132. German Literature of the Nineteenth Century. (3, 3)
First and second semesters. Study of the literary movements from romanticism to naturalism. (Irwin.)

GERM 141-142. German Literature of the Twentieth 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. (Dobert, Staff.)

GERM 171-172. German Civilization. (3, 3)
First and second semesters. Study of the literary, educational, artistic traditions: great men, customs, and general culture. (Morris.)

GERM 191. Bibliography and Methods. (3)
Second semester. Especially designed for German majors. (Jones.)

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 201. History of the German Language. (3)
Lectures on the evolution of modern German. Reading and analysis of selected illustrative texts. (Jones.)

GERM 203. Gothic. (3)
An introduction to historical Germanic linguistics. A grammatical analysis and reading of selections from the Gothic Bible. (Morris.)

GERM 204. Old High German. (3)
A study of Old High German grammar, and readings from the literature of the period. (Jones.)

GERM 205. Middle High German. (3)
Grammar and readings in Middle High German literature. (Jones.)

GERM 209. Introduction to German Studies. (Hering.)

GERM 211-212. Literature of the Sixteenth and Seventeenth Centuries . (3, 3)
Study of the Reformation, Humanism and the Baroque. The main works of Luther, Sachs, Wickram, Fischart, Opitz, Gryphius, Grimmelshausen. (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 Schiller's works with emphasis on his dramas. (Prahl.)

GERM 230. German Romanticism. (3)
Special consideration given to the ideas and the style of romantic writers. (Prahl.)

GERM 234. The German Drama of the Nineteenth 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. (Hering.)

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. (Dobert.)

GERM 291-292. Seminar. (3, 3)
Topic to be determined. (Staff.)

GERM 399. Thesis Research. (Master's Level)
Credits determined by work accomplished. Guidance in preparation of master's and doctoral 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) (Hitchcock.)

RUSSIAN 135. Modern Russian Poetry. (3) (Hitchcock.)

RUSSIAN 136. Modern Russian Drama. (3) (Hitchcock.)

GOVERNMENT AND POLITICS

Professors: Anderson, Burdette, Dillon, Harrison, Hathorn, Hsüeh, Jacobs, McNelly, and Plischke.
Associate Professors: Byrd, Claude, Conway, Koury, Piper, Stone, and Wolfe.
Assistant Professors: Bechtold, Chaples, Devine, Glendening, Heisler, Ingles, Lanning, Arthur Larson, McCarrick, McGreger, Oliver, Spencer, Stevens, Terchek, and Werlin.
Special Lecturers: Alford, Barber, Bowen, Harold Larson, and Reeves.

The Department of Government and Politics offers a graduate course of study leading to the degree of Master of Arts and the degree of Doctor of Philosophy.

For the master's degree, the student may pursue a general program in government and politics or he may specialize in international affairs or in public administration. In addition to the completion of a minimum of 24 semester hours credit of formal course work (excluding thesis credit) in the major and minor fields combined, the master's candidate is required to demonstrate in a written comprehensive examination satisfactory competence in graduate course work in the major field and to write and defend in an oral examination a thesis acceptable to the Department. There is no language requirement for the M.A. degree.

For the doctoral degree, the student may pursue any one of three programs; (1) a general program in government and politics; (2) a specialized program in international affairs—comparative politics; or (3) a specialized program in public administration—urban studies. The doctoral candidate is required to demonstrate in a written comprehensive examination satisfactory competence in five fields of government and politics, the required and elective fields in each case depending upon the particular program pursued. No candidate may attempt the comprehensive examination prior to the fulfillment of the language requirement.

This requirement may be satisfied by the candidate's demonstrating that he possesses either a working knowledge of two foreign languages or a high level of competence in one foreign language. Alternatively, a research methor or procedure may be substituted for a second foreign language. Languages approved by this Department are French, German, Spanish, Russian, Chinese, Japanese,

and Arabic. The completion of a dissertation acceptable to the Department, and defended in oral examination, is the final Ph.D. requirement.

Additional information on the Department's requirements and procedures is contained in a specially prepared "Manual of Instructions for Graduate Study in Government and Politics."

For Graduates and Advanced Undergraduates

GVPT 101. International Political Relations. (3) (Staff.)

GVPT 102. International Law. (3) (Harrison, Piper.)

GVTP 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, A. Larson, MacGregor.)

GVPT 111. Public Personnel Administration. (3)
Prerequisite, GVPT 110 or BSAD 160. (Stevens.)

GVPT 112. Public Financial Administration. (3)
Prerequisite, GVPT 110 or ECON 142. (Ingles.)

GVPT 113. Governmental Organization and Management. (3)
Prerequisite, GVPT 110. (Dillon, McGregor.)

GVPT 120. Problems in Political Behavior. (3)
(Chaples, Conway, Devine, Stone.)

GVPT 124. Legislatures and Legislation. (3) (Chaples, Conway.)

GVPT 131. Introduction to Constitutional Law. (3) (Hathorn, McCarrick.)

GVPT 132. Civil Rights and the Constitution. (3)
Prerequisite, GVPT 131. (Hathorn, Claude, McCarrick.)

GVPT 133. The Judicial Process. (3) (Byrd.)

GVPT 141. History of Political Theory. (3)
(Anderson, Byrd,Claude, Terchek.)

GVPT 142. Recent Political Theory. (3)
A study of the 19th and 20th century political thought, with special emphasis on recent theories of socialism, communism, and fascism.
(Anderson, Byrd, Claude, Terchek.)

GVPT 144. American Political Theory. (3) (Anderson.)

GVPT 145. Russian Political Thought. (3) (Anderson.)

GVPT 154. Problems of World Politics. (3)
A study of governmental problems of international scope, such as causes of war,

problems of neutrality, and propaganda. Students are required to report on readings from current liteature. (Jacobs, Koury.)

GVPT 160. State and Local Administration. (3) (Dillon, Glendening.)

GVPT 161. Metropolitan Administration. (3) (Glendening.)

GVPT 171. Problems of American Public Policy. (3) (Hathorn, A. Larson.)

GVPT 174. Political Parties. (3) (Reeves, Conway, Devine.)

GVPT 178. Public Opinion. (3) (Devine.)

GVPT 181. Administrative Law. (3) (Staff.)

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)
Prerequisite, GVPT 097 or 105, or HIST 061, 062, 187, 188, or 189. (McNelly, Hsüeh.)

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)
Prerequisites, GVPT 097 and at least one other course in comparative government. (Heisler, Lanning, Wolfe.)

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, A. Larson.)

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 Government and Politics of Emerging 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. (Staff.)

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 211. Seminar in Federal-State Relations. (3)
Reports on topics assigned for individual study and reading in the field of recent federal-state relations. (Dillon, A. Larson, Reeves.)

GVPT 213. Problems. of Public Administration. (3)
Reports on topics assigned for individual study and reading in the field of public administration. (Dillon, A. Larson, MacGregor, Stevens.)

GVPT 214. Problems. of Public Personnel Administration. (3)
Reports on topics assigned for individual study and reading in the field of public personnel administration. (Stevens.)

GVPT 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 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 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 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 225. 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 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 227. 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 communications theory, decision-making, game theory and other mathematical concepts, personality theory, role theory, structural-functional analysis, and current behavioral approaches. (Terchek.)

GVPT 231. Seminar in Public Law. (3)
Reports on topics assigned for individual study and reading in the fields of constitutional and administrative law. (Hathorn, Claude, McCarrick.)

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

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

HISTORY

Professors: Bauer, Cole, Gordon, Haber (*Head*), Harlan, Jashemski, Koch, Merrill, Prange, Smith, and Sparks.
Associate Professors: Belz, Breslow, Brush, Callcott, Folsom, Giffin, Gilbert, Grimsted, Mayo, Rivlin, and Yaney.
Assistant Professors: Beveridge, Bradbury, Brann, Carter, Farrell, Flack, Greenberg, Harris, Matossian, Nicklason, Olson, Robertson, Stowasser, Van Ness, Warren, Williams, and Wright.
Lecturers: Barillari, Blassingame, Cockburn, McCusker, Perinbam, Vasquez.

MASTER OF ARTS

Requirements for the M.A. include: (1) writing an acceptable thesis; (2) successful completion of HIST 200; (3) passing a four-hour written examination over the major field; and (4) passing an oral examination over the thesis and the field in which it lies. Information about a possible non-thesis option is available in the departmental office. At least fifteen hours of the total required for an M.A. must be in history, and at least nine of these shall be in the field of concentration.

DOCTOR OF PHILOSOPHY

Candidates for the Ph.D. 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; Latin American history; East Asian history; and history of the

Middle East and Islamic civilization. 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 Ph.D. language requirement 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) (Staff.)

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)
The development of the American economy and its institutions. First semester, to 1865; second semester, since 1865. (Staff.)

HIST 109, 110. Social History of the United States. (3, 3)
Formation of regional societies; immigration and nativism; the Negro; urban movement; social responses to technological change. First semester, to 1865; second semester, since 1865. (Beveridge.)

HIST 114. The Middle Period of American History, 1824-1860. (3)
An examination of the political history of the United States from Jackson to Lincoln with particular emphasis on the factors producing Jacksonian democracy, Manifest Destiny, the Whig Party, the anti-slavery movement, the Republican Party, and secession. (Sparks.)

HIST 115. History of the South. (3)
Prerequisite, HIST 021, 022, or the equivalent. (Calcott.)

HIST 116. The Civil War. (3) (Sparks.)

HIST 117. The Negro in American Life. (3)

HIST 118. The Progressive Period: The United States, 1896-1919. (3)

HIST 119. Between the Wars: The United States, 1919-1945. (3)

HIST 120. The United States Since World War II. (3)

HIST 121. History of the American Frontier. (3) (Staff.)

HIST 124. Reconstruction and the New Nation, 1865-1896. (3)
Prerequisite, HIST 021, 022, or the equivalent. (Staff.)

HIST 127, 128. Diplomatic History of the United States. (3, 3)
A historical study of the diplomatic negotiations and foreign relations of the United States. First semester from the Revolution to 1896. Second semester, from 1898 to the present. (Cole.)

HIST 133, 134. The History of Ideas in America. (3, 3)
A history of basic beliefs about religion, man, nature, and society. Consent of the instructor is required for HIST 134. (Koch.)

HIST 135, 136. Constitutional History of the United States. (3, 3) (Belz.)

HIST 137. The Scientific Revolution: From Copernicus to Newton. (3)
Major developments in the history of physics and astronomy during the 16th and 17th centuries and critical evaluations of the Copernican Revolution, the "mechanical philosophy" of the 17th century scientists, and the Newtonian synthesis and its impact on 18th century thought. (Brush.)

HIST 138. The Development of Modern Physical Science: From Lavoisier to Einstein .(3)
History of chemistry, physics, and geology during the period from 1775 to about 1925. 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)
Political, social, and economic development of Spain; the Spanish empire; Spain's role in Europe. Some attention will be paid to Portuguese history. First semester, 1469-1700; second semester, 1700-present. (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) (Giffin.)

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)
Europe in the Age of Louis XIV and the Enlightened Despots. (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. Beginning with a review of the basic Western intellectual traditions as a heritage from the Ancient World, the course will present selected important currents of thought

from the scientific revolution of the sixteenth and seventeenth century down to the twentieth century. First semester, through the eighteenth century. Second semester, nineteenth and twentieth centuries. (Haber.)

HIST 161, 162. The Renaissance and Reformation. (3, 3)
Prerequisite, HIST 041, 042, 053, or consent of instructor. City-states and the rise of nation-states, the culture and thought of the Renaissance, the Reformations and their impact into the seventeenth century. (Brann.)

HIST 163, 164. History of the British Empire. (3, 3)
Prerequisites, HIST 041, 042, or HIST 053, 054. First semester, the development of England's Mercantilist Empire and its fall in the war for American Independence (1783). Second semester, the rise of the Second British Empire and the solution of the problem of responsible self-government (1783-1867), the evolution of the British Empire into a Commonwealth of Nations, and the development and problems of the dependent Empire. (Gordon.)

HIST 165, 166. Constitutional History of Great Britain. (3, 3)
A survey of constitutional development in England with emphasis on the history of the royal prerogative, the growth of the common law, the development of Parliament, and the emergence of systematized government. First semester, to 1485; second semester, since 1485. (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. A study of the political, economic, social and cultural development of Europe from the Congress of Vienna to the First World War. First semester, 1815-1870; second semester, 1870-1914. (Bauer)

HIST 171, 172. Europe in the World Setting of the Twentieth Century. (3, 3)
Prerequisites, HIST 041, 042, or HIST 053, 054. A study of political, economic, and cultural developments in twentieth century Europe with special emphasis on the factors involved in the two World Wars and their global impacts and significance. (Prange)

HIST 173. The Soviet Union. (3) (Matossian.)

HIST 175. Modern France. (3)
A survey of French history from 1815 to the present. The emphasis is upon such topics as the population problem, the economic and social structure of French society, and the changing political and cultural values of this society in response to recurrent crises through the nineteenth and twentieth centuries. (Greenberg)

HIST 176. Tudor England. (3) (Breslow)

HIST 177. Stuart England. (3) (Breslow)

HIST 178. Britain in the Eighteenth Century. (3)
Developments in Great Britain from the Revolution of 1688 to the end of the Napoleonic wars. (Cockburn.)

HIST 179. Modern Britain. (3)
A survey of British history from the age of the French Revolution to World War I with emphasis upon such subjects as Britain's role in the world, the democratization of the state, the problems arising from industrialism and urbanism, and Irish and imperial problems. (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. A survey of the historical and institutional developments of the nations of this vital area. The Islamic Empires and their cultures; impact of the west; breakup of the Ottoman Empire and rise of nationalism; present day problems.

HIST 183. A Survey of African History. (3)
A brief survey of the history of sub-Saharan Africa from prehistoric times to the end of the colonial era. Special focus on neolithic civilizations, major migrations, and political and commercial developments in pre-colonial and colonial Africa. (Perinbam.)

HIST 184. A History of West Africa. (3)
HIST 183 recommended though not required. A regional study of the western Sudan, forest and coastal regions from pre-historic times to the nineteenth century. A dissussion of neolithic and iron age civilizations, trans-Saharan and other trade, introduction of Islam, medieval sudanese empires, forest kingdoms, nineteenth century empires and kingdoms, and the impact of European penetration. (Perinbam.)

ASIAN HISTORY

HIST 187, 188. History of China. (3, 3) (Folsom.)

HIST 189, 190. History of Japan. (3, 3)
First semester, Japanese civilization from the age of Shinto mythology, introduction of continental learning, and rule of military overlords. Second semester, renewed contact with the western world and Japan's emergence as a modern state. (Mayo.)

HIST 191. History of the Arabs. (3)
HIST 071 and 072 recommended but not required. (Rivlin.)

HIST 192. History of the Turks. (3)
HIST 071 and 072 recommended but not required. (Rivlin.)

HIST 193. History of Iran. (3)
HIST 071 and 072 recommended but not required. (Rivlin.)

HIST 194. History of the Jews and the State of Israel. (3) (Rivlin.)

For Graduates

HIST 200. Historiography: Techniques of Historical Research and Writing. (3) (Staff.)

HIST 201. Readings in Colonial American History. (3) (Staff.)

HIST 202. Seminar in Colonial American History. (3) (Staff.)

HIST 203. Readings in the American Revoiution 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) (Sparks.)

HIST 216. Seminar in the Middle Period and Civil War. (3) (Sparks.)

HIST 217. Readings in Reconstruction and the New Nation. (3) (Staff.)

HIST 218. Seminar in Reconstruction and the New Nation. (3) (Staff.)

HIST 223. Readings in Recent American History. (3) (Shannon, Merrill, Harlan, Olson.)

HIST 224. Seminar in Recent American History. (3) (Shannon, 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) (Koch.)

HIST 234. Seminar in American Intellectual History. (3) (Koch.)

HIST 236. Seminar in American Constitutional and Political History. (3) (Belz.)

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) (Giffin, Wright.)

HIST 246. Seminar in Latin American History. (3) (Giffin, 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) (Haber.)

HIST 260. Seminar in Modern European Intellectual History. (3) (Haber.)

HIST 261. Readings in the History of the Renaissance and Reformation. (3) (Brann.)

HIST 262. Seminar in the History of the Renaissance and Reformation. (3)

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) (Bauer.)
HIST 270. Seminar in Nineteenth Century Europe. (3) (Bauer.)
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) (Rivlin.)
HIST 282. Seminar in Middle Eastern History. (3) (Rivlin.)
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 Teaching 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, Mitchell, Prather, and Shearer.
Associate Professors: Ahrens, Brown, Butler, Lemmon, Olson, and Wilson.
Assistant Professors: Churaman, Eheart, and Wilbur.

The college 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 ac-

complished. 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. Food Purchasing and Cost Control. (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 personnal 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. (3)
First semester. Two lectures and one two-hour laboratory a week. Prerequisite, consent of instructor. Equipment design, selection, maintenance and efficient layout; relation of the physical facility to production and service. Field trips.

IDAM 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.
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 114. Nutrition for Health Services. (3)
First and second semesters. Prerequisite, NUTR 020, CHEM 001, 003, or equivalent. A study of nutritional status and the effect of food habits and food consumption on family health. Nutritional requirements for individuals in different stages of development. Techniques and procedures for the application of nutrition knowledge with consideration of various economic levels and social backgrounds. For graduate nurses, dietitians, health teachers, and social workers.

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, deficiencies.

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)
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.

FAMILY AND COMMUNITY DEVELOPMENT

For Advanced Undergraduates and Graduates

FMLF 130. Home Management and Family Life. (3)
First semester. Prerequisites, PSYC 001; MGT 050; HOEC 005. Study of factors influencing establishment and maintenance of satisfying interpersonal relations throughout the family life cycle as affected by management in the home.

FMLF 132. The Child in the Family. (3)
Second semester. Three lectures. Prreequisite, PSYC 001; HOEC 005 or equivalent. 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.

FMLF 135. Directed Experiences with Children and Families. (3)
First and second semesters. Prerequisite, PSYC 001 and consent of department. Observation and study of selected home situations placing emphasis on contemporary family living. This course is designed especially for students who wish an understanding of children of various ages in relation to the family and the quality of living achieved in a variety of life situations. (Limited to majors in the College of Home Economics.)

HMGT 140. Fundamentals of Housing. (3)
Second semester. Two lectures and one two-hour laboratory a week. Prerequisite, HMGT 050 or equivalent.

HMGT 160. Scientific Management in the Home. (3)
First and second semesters. Two lectures and one two-hour laboratory period a week. Prerequisite, HMGT 050 or equivalent.

HMGT 161. Resident Experience in Home Management. (3)
First and second semesters. Prerequisites, HMGT 050, 160; 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.

HMGT 162. Personal and Family Finance. (2)
First semester. Prerequisite, HMGT 050. Study of factors influencing use of money; how families attempt to achieve financial security; interrelationship of money and other resources; types of credit. Emphasis on management of the family's money.

HMGT 165. Home Management Practicum. (3)
First and second semesters. Prerequisite, HMGT 050, 160; FOOD 060; or equivalent; consent of department. Home management experience under supervision in a variety of situations. Designed especially for students who are managing their own homes.

APPLIED DESIGN

APDS 120. Fashion Illustration. (3)
First semester. 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)
Second semester. Three laboratory periods. Prerequisite, APDS 120. Design and illustration of fashions appropriate to the custom market and to mass production.

APDS 122, 123. Advanced Costume. (2, 2)
First and/or second semesters. Prerequisite, APDS 120 or 121. Advanced problems in fashion illustration or design. Problems chosen with consent of instructor.

APDS 130. Typography and Lettering. (3)
First and second semesters. 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)
First semester. Two laboratory periods. Prerequisites, APDS 130, INED 001. Design of advertising layouts from initial idea to finished layout. Typography and illustration as they relate to reproduction processes used in direct advertising.

APDS 134, 135. Advanced Problems in Advertising Design. (3, 3)
Second semester. Two laboratory periods. Prerequisite: APDS 132. Advanced problems in design and layout planned for developing competency in one or more areas of a advertising design.

APDS 136. Display Design. (3)
First and second semesters. 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)
First and second semesters. Two laboratory periods. Prerequisite: APDS 038. Composition, techniques, and lighting applicable to illustration, documentation, advertising design and display.

APDS 139. Advanced Photography. (3)
First and second semesters. Three laboratory periods. Continuation of APDS 138.

APDS 180. Professional Seminar. (2)
Second semester. 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)
First semester. Prerequisites: APDS 001, HSAD 046, or equivalent.

HSAD 141. Contemporary Developments in Architecture, Interiors, Furnishings. (3)
Second semester. Prerequisite: HSAD 046 and consent of instructor.

HSAD 142. Space Development. (3)
First semester. 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)
First semester. 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)
Second semester. 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)
First and second semesters. One lecture plus work experience.

HSAD 146-147. Interior Design III, IV. (4, 4)
First and/or second semesters. 8 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)
Second semester. 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. Problem chosen with consent of instructor.

CRAFTS

CRAF 102. Creative Crafts. (3)
First and second semesters. 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)
First and second semesters. Three laboratory periods. Prerequisite, CRAF 020.

CRAF 130, 131. Advanced Metalry I, Advanced Metalry II. (2, 2)
First semester. 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)
Second semester. 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 AND CLOTHING

For Graduates and Advanced Undergraduates

TXCL 101. Fashion Promotion and Coordination. (3)
Second semester. Two lectures and one laboratory period a week. Prerequisites, TXCL 126; SPCH 115 or 117. Analysis of fashion media; industry publications, magazines, newspapers, radio, TV; merchandise displays and fashion shows. Role of the stylist.

TXCL 110. Field Experience in Textiles and Clothing. (3)
First semester or summer school. Prerequisite, senior standing in department. Supervised and coordinated training-work program in cooperation with agencies and organizations.

TXCL 126. Fundamentals of Fashion. (3)
Second semester. Prerequisite, CLTH 120. Fashion history; current fashions, how to interpret and evaluate them; fashion show techniques; fashion promotion. The course includes oral and written reports, group projects, panel discussions and field trips.

TXCL 128. Fundamentals of Home Furnishings. (3)
First and second semesters. Three laboratory periods a week. Prerequisites, TXCL 005, CLTH 010, or consent of instructor.

For Graduates and Advanced Undergraduates

TEXT 102. Textile Testing. (3)
Second semester. Three laboratory periods a week. Prerequisite, TEXT 150.

TEXT 150. Advanced Textiles. (3)
First semester. One lecture and two laboratory periods a week. Prerequisite, TEXT 055.

TEXT 153. International Textiles. (2)
First semester. Two lectures a week. Prerequisite, TXCL 005, or consent of instructor.

CLOTHING

CLTH 100. Family Clothing. (3)
First semester in alternate years. One lecture and two laboratory periods a week. Prerequisites, TXCL 005, CLTH 010, 011, or equivalent. Clothing the family; analysis of needs of family members in various stages of life cycle; individual and family budgets; problems in selection and/or construction of wardrobe items.

CLTH 120. Draping. (3)
First semester. Two laboratory periods a week. Prerequisite, CLTH 010.

CLTH 122. Tailoring. (2)
First and second semesters. Two laboratory periods a week. Prerequisite, CLTH 021.

CLTH 127. Apparel Design. (3)
Second semester. One lecture and two laboratory periods a week. Prerequisite, CLTH 120. The art of costuming; trade and custom methods of clothing design and construction; advanced work in draping, pattern design and/or tailoring, with study of the interrelationship of these techniques.

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, PSYC 021 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, and Thompson.
Associate Professor: Wiley.

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. (Offered 1968-69.) Three lectures per week. Prerequisite, HORT 006; prerequisite or concurrent BOTN 101. (Thompson.)

HORT 103. Technology of Vegetables. (3)
Second semester. (Offered 1969-70.) 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. (Offered 1968-69.) Three lectures per week. Prerequisite BOTN 117. (Angell.)

HORT 114. Systematic Horticulture. (3)
First semester. Two lectures and one laboratory period a week. (Angell.)

HORT 161. Physiology of Maturation and Storage of Horticultural Crops. (2)
Second semester, alternate years. (Offered 1968-69.) 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. Three lectures per week. (Link.)

HORT 163. Production and Maintenance of Woody Plants. (3)
Second semester, alternate years. (Offered 1969-70.) Two lectures and one laboratory period a week. Prerequisite or concurrent HORT 062; 108. (Link.)

HORT 198. Special Problems. (2, 2)
First and second semesters. Credit arranged according to work done. For major students in horticulture or botany. Four credits maximum per student. (Staff.)

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. (Offered 1969-70.) Three lectures per week. Prerequisite, BOTN 101. (Reynolds.)

HORT 212. Chemical Regulation of Growth of Horticultural Plants. (3)
Second semester, alternate years. (Offered 1969-70.) Three lectures per week. Prerequisite, BOTN 101. (Shanks.)

HORT 213. Environmental Factors and Horticultural Plants. (3)
First semester, alternate years. (Offered 1968-69.) Three lectures per week. Prerequisite, BOTN 101. (Thompson.)

HORT 214. Breeding of Horticultural Plants. (3)
Second semester, alternate years. (Offered 1968-69.) Three lectures per week. Prerequisite, HORT 109 or permission of instructor. (Angell.)

HORT 301. Special Problems in Horticulture. (1-3) S.C.
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 4 hours of experimental work plus any credit obtained in a specialized lecture series.
A) Problems
B) Physiology and Technology of Pectins
C) Plants and Light
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.

HORT 399. Thesis Advanced Horticultural Research. (Master's Level)
First and second semesters; summer session. (Staff.)

HORT 499. Dissertation Advanced Horticultural Research. (Doctoral Level)
Experimental Procedures in Agricultural Sciences, see Agriculture, AGRI 210.
Principles of Food Processing I, see Food Science, FDSC 102. (Wiley.)
Analytical Quality Control, see Food Science, FDSC 112. (Kramer.)
Statistical Quality Control, see Food Science, FDSC 113. (Kramer.)
Horticultural Products Processing, see Food Science, FDSC 156. (Wiley.)
Advances in Food Technology, see Food Science, FDSC 201. (Kramer.)
Seminar in Food Science, see Food Science, FDSC 302. (Staff.)
Colloquium in Food Science, see Food Science, FDSC 310. (Staff.)

SPECIAL COURSES FOR TEACHERS OF VOCATIONAL AGRICULTURE

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.)

INFORMATION SYSTEMS MANAGEMENT

Professor: Patrick.
Assistant Professor: Sprague.
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. The electronic digital computer and its use as a tool in processing data. The course includes the following areas: (1) Organization of data processing systems, (2) environmental aspects of computer systems. (3) fundamentals of programming using a common problem-oriented language, and (4) management control problems and potentials inherent in mechanized data processing systems.

ISM 102. Electronic Data Processing Applications. (3)
Prerequisite, ISM 101 and BSAD 130, or consent of instructor.

ISM 103. Introduction to Systems Analysis. (3)
Prerequisite, ISM 102, BSAD 130, MATH 020, 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 020 or equivalent; ISM 102, BSAD 130, and some familiarity with administrative, economic and/or political models. Prerequisites may be waived with the consent of instructor. Data processing requirements underlying the creation and maintenance of a data base to be used in estimating the parameters of socio-economic models. An analysis of the structure and development of recent socio-economic models as relevant to data processing considerations. Extraction and preparation of data from the data base to facilitate the appropriate transformation necessary for model construction and also to minimize the processing cost of data input. The course draws upon a knowledge of models of administrative, economic and political systems. Case studies and experience with data processing for selected models are included.

ISM 120. Information Processing and Computational Problems in Operations Analysis. (3)
Prerequisites, MATH 020 or equivalent; ISM 102, and a course in Statistics, such as BSAD 135, dealing with multivariate models. Prerequisites may be waived with the consent of the instructor. Implementation of applications requiring the integration of data processing and analytical programming techniques. Such applications feature the calculation of various statistical estimates of the parameters in a multivariate model within the context of a file maintenance problem (e.g., the writing of a matrix inversion routine for revenue forecasting within a master updating program, or sales forecasting and/or sales performance evaluation within a sales transaction—master updating program). Programming tools include a universal, problem-oriented language such as COBOL with strong emphasis on the use of the mathematical FORTRAN IV library subroutines. Class projects include case studies and solutions of problems using real-world data.

ISM 167. Operations Research I. (3)
Prerequisite, BSAD 130 or 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. Docu-

mentation 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

The Institute for Fluid Dynamics and Applied Mathematics is a center for fundamental theoretical and experimental research in the physical and mathematical sciences. It plays a vital role in the University program of higher education by providing facilities for predoctoral and postdoctoral study. Further, it provides an important link between the University and the broad scientific and technological community.

Investigations in applied mathematics traditionally have centered on partial differential equations of mathematical physics, specifically initial value, boundary value and eigenvalue problems and their numerical treatment. More recently, attention has been drawn to current questions in ordinary differential equations such as hereditary dependence and control theory, and to mathematical methods in statistical mechanics and theoretical biology. Theoretical studies of gas dynamics and plasma dynamics are carried out in conjunction with laboratory investigations employing facilities such as shock tubes and a thermal plasma device (Q-machine). Applications to astrophysics, e.g., the elemental abundance problem, to nonlinear mechanics and to space physics engage the attention of the staff. The meteorological program is closely associated with studies in fluid dynamics. Model experiments in rotating tanks have been used to simulate atmospheric conditions. Interaction of atmosphere and oceans are under investigation. Research on the atmospheric boundary layer, including turbulence, diffusion and micro-meteorological analysis is underway. This ties in with problems of atmospheric pollution and local climatic changes. This program offers a whole range of graduate courses leading to M.S. and Ph.D. degrees. The Institute's research program is partially supported by outside contracts and grants.

Staff members are available for thesis direction of graduate students pursuing advanced degrees in various departments of the University. Approximately 145 master's and Ph.D. degrees were earned during the period 1951-68 in the departments of Mathematics, Physics and Astronomy, Mechanical Engineering and Aerospace Engineering under the direction of Institute faculty. In addition, staff members have taught many graduate and undergraduate courses in other departments of the University. Fellowships and research graduate assistantships are available to support the studies of qualified graduate students, and the Institute offers its facilities and financial support both to post-doctoral fellows and senior scholars on leave from other institutions.

Institute staff members work closely with faculty and staff of other University departments on problems of mutual interest, and with scientists at many governmental and educational institutions in the Washington-Baltimore area.

INSTITUTE FOR MOLECULAR PHYSICS

Professors: Benedict, Benesch, Vanderslice, and Zwanzig.*
Associate Professors: De Rocco, Krisher, Munn, and Sengers.
Assistant Professors: Ginter, Spain, and Verbeke.

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 or 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, Bundy, Heilprin, and Kidd.
Associate Professors: Liesener, McGrath, and Olson.
Assistant Professor: Colson, and Warner.
Lecturers: Hodina, Mann, Moses, Reid, and Thomas.
Visiting Lecturers: Foskett, and Levy.
Adjunct Lecturers: Andriot, Applebaum, Bougas, Dubester, Kuri, Lahood, Lancaster, Lebowitz, Martin, Meadow, and Walston.
Instructors: MacLeod, and Sloan.

OBJECTIVES

The curriculum deals with those areas of knowledge basic to the professional practice of library and information activity. The program is designed to prepare librarians and information specialists for beginning professional work in each of the specialties. This sequence of study includes a core of required courses for all students, numbering twenty-four semester hours, to which are added twelve hours of specialized and elective courses, leading to the M.L.S. degree. Courses in the School are open to qualified graduate students in other disciplines with the consent of the instructor.

For Graduates

Required Core Courses

LBSC 200. Introduction to Data Processing for Libraries. (3)
systems analysis in relation to library functions and procedures.
(Lamkin, Walston.)

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.
(McGrath.)

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.
(Foskett, Levy.)

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. (Kuri, Lebowitz.)

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, Sloan.)

LBSC 211. Library Administration. (3)
An introduction to administrative theory and principles and their implications and applications to managerial activity in libraries. (Bundy, 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.)

Electives

LBSC 220. Public Library in the Political Process. (3)
Seminar in the principal influences which affect the patterns of organization, support and service patterns of public libraries based upon theoretical and case studies. (Bundy, 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. (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. (Foskett.)

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 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. (Lancaster.)

LBSC 228. Analytical Bibliography and Descriptive Cataloging. (3)
Concentrates on the techniques and theories appropriate to the study of bibliographic morphology and bibliographical description. (McGrath.)

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 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. (Andriot, Warner.)

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 244. Medical Literature. (3)
Survey and evaluation of information sources in medicine, with emphasis upon the bibliographic organization of the field. (Martin.)

LBSC 245. Legal Literature. (3)
Survey and evaluation of information sources in law, with emphasis upon the bibliographic organization of the field. (Bougas.)

LBSC 249. Seminar in Technical Services. (3)
Treatment of special administrative problems related to acquisition, cataloging and classification, circulation, and managerial controls. (Applebaum.)

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. (Lattood.)

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, Warner.)

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. (Staff.)

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. (Thomas.)

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 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 signficance 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. (Moses, Reid.)

LBSC 271. Advanced Reference Services. (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 collections, 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 supervision. (Staff.)

MATHEMATICS

Professors: Auslander, Brace, Chu, Cohen, Douglis, Edmundson,** Goldberg, Goldhaber, Good, Greenberg, Horvath, Hubbard,* Hummel, Jackson, Jones,* Karp, Kleppner, Kuroda, J. Lehner, Martin,* Pearl, Reinhart, Rheinboldt,** Rosenfeld,** Stellmacher, Syski, Walsh, Zedek, and Zwanzig.*

Associate Professors: Benedetto, Bernstein, Cook, Correl, Daniel, Ehrlich, Gray, Gulick, Henkelman,*** Karlovitz,* Kellogg,* Kirwan, G. Lehner, Lopez-Escobar, Maltese, Mikulski, Ortega,* Sather, Strauss, and Trytten.*

Assistant Professors: Austing,** Berg, Connell, Currier, Dancis, Davidson,*** Egan, Ellis, Garstens,*** Gowen, Green, Helzer, Holzsager, Johnson, Lay, Markley, Neri, Osborn, Owings, Rastogi, Schneider, Sedgewick, Shepherd, Thaler, Timsans, Vandergraft,** Wagner, Warner, Wolfe, and Yorke.*

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.

A student majoring in a subject other than mathematics who intends to present a minor in mathematics should obtain approval of his minor program from the Adviser on Minors at an early stage of his work. The name of the current adviser may be obtained from the Graduate Committee Office.

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,

* Member of Institute for Fluid Dynamics and Applied Mathematics
** Member of Computer Science Center
*** Joint Appointment—Department of Secondary Education

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 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, 112, 113, 114, 117, 118, 119, 165, 212, 215, 216, 218, 219, 265, 266, 272, 278, 280, 281, 282, 283, 286, 287, 288, 289, 294, 295.

COURSES IN GEOMETRY AND TOPOLOGY:

120, 121, 122, 123, 124, 126, 128, 204, 205, 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.
Math 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. (Good.)

MATH 101. Applied Linear Algebra. (3)
Prerequisite, MATH 100 or consent of the instructor. Various applications of linear algebra: theory of finite games, linear programming, matrix methods as applied to finite Markov chains, random walk, incidence matrices, graphs and directed graphs, networks, transportation problems. (Pearl.)

MATH 103. Introduction to Abstract Algebra. (3)
Prerequisite, MATH 022 or equivalent. Integers, groups, rings, integral domains, fields. (Staff.)

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. (Staff.)

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, cyclotomic polynomial, congruences and quadratic residues, Legendre's and Jacobi's symbol, reciprocity law of quadratic residues, introductory explanation of the method of algebraic number theory. (Kuroda.)

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. (Kuroda.)

MATH 110. Advanced Calculus. (3)
Prerequisite, MATH 022. 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. (Staff.)

MATH 112. Infinite Processes. (3)
Prerequisite, MATH 021 or equivalent. Construction of the real numbers from the rational numbers, sequences of numbers, series of positive and arbitrary numbers, infinite products, conditional and absolute convergence, sequences and series of functions, uniform convergence, integration and differentiation of series, power series and analytic functions, Fourier series, elements of the theory of divergent series, extension of the theory to complex numbers and functions. (Staff.)

MATH 113. Introduction to Complex Variables. (3)
Prerequisite, MATH 119. 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.) (Berg.)

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. (Staff.)

MATH 117. Introduction to Fourier Analysis. (3)
Prerequisite, MATH 113. Fourier series. Fourier and Laplace transforms. (Horvath.)

MATH 118. Introduction to Real Variables. (3)
Prerequisite, MATH 110. The Lebesgue integral. Fubini's theorem. Convergence theorems. The Lp spaces. (Staff.)

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, including integration by parts. Applications to partial differential equations and potential theory. (Staff.)

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. (Staff.)

MATH 121. Introduction to Geometry II. (3)
Prerequisite, MATH 120. Non-Euclidean transformation groups, the Erlangen program, projective planes, cubics and quartics. (Staff.)

MATH 122. Introduction to Point Set Topology. (3)
Prerequisite, MATH 110 or 146, or equivalent. Connectedness, compactness, transformations, homeomorphisms; application of these concepts to various spaces, with particular attention to the Euclidean plane. (Dancis, Reinhart.)

MATH 123. Introduction to Algebraic Topology. (3)
Prerequisite, MATH 122 and 103, or equivalent. Chains, cycles, homology groups for surfaces, the fundamental group. (Reinhart.)

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. (Jackson.)

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. (Correl.)

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. (Staff.)

MATH 144. Recursive Function Theory. (3)
Prerequisite, MATH 021 or consent of instructor. An informal development of propositional and predicate logic leading to a discussion of recursive functions, Turing machines, and finite automata. Topics include word problems, the classification of recursively enumerable sets, recursive reducibility. (Owings.)

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. (Cohen, Ehrlich.)

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. (Karp.)

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. (Karp, Lopez-Escobar.)

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.) (Martin.)

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.) (Sedgewick.)

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.) (Berg.)

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. (Staff.)

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 equations, errors in numerical calculations. (This course cannot be counted toward a major in mathematics.) (Austing.)

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. (Vandergraft.)

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. (Vandergraft.)

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 developments of the real numbers. Elementary number theory. (Staff.)

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. (Staff.)

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. (Staff.)

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). (Staff.)

MATH 185. Selected Topics for Teachers of Mathematics. (1-3)
Prerequisite, one year of college mathematics or consent of instructor. (Staff.)

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. (Staff.)

MATH 190. Honors Seminar. (2)
Prerequisite, permission of the departmental Honors Committee. Reports by students on mathematical literature; solution of various problems. (Staff.)

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. (Staff.)

STAT 100. Applied Probability and Statistics I. (3)
Prerequisite, MATH 021. Basic concepts of probability. Random variables and distribution functions, standard distributions, moments. Conditional distributions and their moments. Sampling distributions. Laws of large numbers and Lindeberg-Levy's theorems. Graduate students majoring in mathematics cannot take this course for credit. (Connell.)

STAT 101. Applied Probability and Statistics II. (3)
Prerequisite, STAT 100. Point estimation, sufficient unbiased and consistent estimators. Minimum variance and maximum likelihood estimators. Multivariate normal distribution. Sampling distributions. Interval estimation. Testing hypotheses. Regression and linear hypotheses. Experimental designs. Sequential tests, elements of nonparametric methods. Graduate students majoring in mathematics cannot take this course for credit. (Rastogi.)

STAT 110. Introduction to Probability Theory. (3)
Prerequisite, MATH 110 or STAT 050, with concurrent MATH 110. Probability space and basic properties of probability measure. Random variables and their distribution functions, induced probability spaces. Multi-dimensional distribution functions. Characteristic functions. Limit theorems. (Daniel.)

STAT 111. Introduction to Stochastic Processes. (3)
Prerequisite, STAT 110, or MATH 110 and STAT 050. 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. (Edmundson.)

STAT 120. Introduction to Statistics I. (3)
Prerequisite, STAT 110, or STAT 100 and MATH 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. (Mikulski.)

STAT 121. Introduction to Statistics II. (3)
Prerequisite, STAT 120, or STAT 101 and MATH 110. 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. (Mikulski.)

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. (Rastogi.)

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.) (Rastogi.)

STAT 170. Linear and Nonlinear Programming. (3)
Prerequisite, 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. (Daniel.)

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. (Goldhaber, Pearl.)

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. (Markley.)

MATH 202. Homological Algebra. (3)
Prerequisite, MATH 200. Projective and injective modules, homological dimensions, derived functors, spectral sequence of a composite functor. Applications. (Helzer.)

MATH 203. Commutative Algebra. (3)
Prerequisite, MATH 200. Ideal theory of Noetherian rings, valuations, localizations, complete local rings, Dedekind domains. (Wagner.)

MATH 204, 205. Topological Groups. (3, 3)
Prerequisites, MATH 286, and MATH 289 or MATH 225, or consent of instructor. General nature of topological groups including homomorphism theo-

rems, Haar measure, representations of compact groups and the Peter-Weyl Theorem, Pontrjagin duality and the Plancherel Theorem. (Kleppner.)

MATH 206. Algebraic Number Theory I. (3)
Prerequisites, MATH 286, and MATH 289 or MATH 225, or consent of in-braic 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 ideal with respect to a relatively Galois extension. (Kuroda.)

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. (Kuroda.)

MATH 208. Ring Theory. (3)
Prerequisite, MATH 201 or consent of instructor. According to the needs of the class, emphasis will be placed on one or more of the following: ideal theory, structure theory of rings with or without minimum condition, division rings, algebras, non-associative rings. (Wagner.)

MATH 209. Group Theory. (3)
Prerequisite, MATH 201 or consent of instructor. According to the needs of the class, emphasis will be placed on one or more of the following aspects of discrete group theory: finite groups, abelian groups, free groups, solvable or nilpotent groups, groups with operators, groups with local properties, groups with clan conditions, extensions. (Egan.)

MATH 212. Special Functions. (3)
Prerequisite, MATH 287 or consent of instructor. Gamma-function, Riemann zeta-function, hypergeometric functions, confluent hypergeometric functions and Bessel functions. (Stellmacher.)

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. Nonlinear systems. Topics of current interest. (Strauss, Wolfe.)

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. (Goldberg, Lay.)

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. (Chu, Reinhart.)

MATH 222. Differential Geometry. (3)
Prerequisite, MATH 220—Differential Geometry of Curves and Surfaces (previously offered) or MATH 221. Connections, curvature, torsion: symplectic contact, and complex structures. (Chu, Reinhart.)

MATH 223, 224. Algebraic Topology. (3, 3)
Prerequisite, MATH 226 or both MATH 200 and MATH 225. 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. (Holzsager.)

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. (Ellis, Reinhart.)

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. (Green.)

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. (Thaler.)

MATH 229. Differential Topology. (3)
Prerequisite, MATH 221. Characteristic classes, cobordism, differential structures on cells and spheres. (Reinhart.)

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. (Karp.)

MATH 244. Mathematical Logic. (3)
Prerequisite, MATH 148. Completeness of first-order predicate logic and applications, recursive functions, Godel's incompleteness theorem. (Lopez-Escobar.)

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. (Kellogg, Wolfe.)

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 inequalities. (Kellogg, Wolfe.)

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. (Trytten.)

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. (Karlovitz.)

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. (Hubbard.)

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, equation of motion for fluid bodies, stress-strain relations, equations of perfect fluids and formulation of viscous flow problems. (Staff.)

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. (Staff.)

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. (Staff.)

MATH 264. Non-Linear Elasticity. (3)
Prerequisite, MATH 259. Fundamentals of non-linear elasticity, finite deformations, rubber elasticity, small deformations superimposed on finite deformations. (Staff.)

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 functions, the method of integral equations. (Osborn.)

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. (Douglis.)

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. (Rheinboldt.)

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. (Rheinboldt.)

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. (Daniel.)

MATH 271. Selected Topics in Algebra. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 272. Selected Topics in Analysis. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 273. Selected Topics in Geometry and Topology. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 274. Selected Topics in Applied Mathematics. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 275. Selected Topics in Probability. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 276. Selected Topics in Statistics. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 277. Selected Topics in Mathematical Logic. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 278. Advanced Topics in Complex Analysis. (3)
Prerequisite, consent of instructor. Material selected to suit interests and background of the students. (Staff.)

MATH 280, 281. Linear Spaces. (3, 3)
Prerequisite, MATH 218. Linear topological spaces, locally convex spaces, duality theory, distributions. (Brace, Ellis.)

MATH 282, 283. Interpolation and Approximation. (3, 3)
Prerequisites, 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. (Walsh, Zedek.)

MATH 286. Real Analysis I. (3)
Prerequisite, MATH 110 or equivalent. Lebesgue measure and integration on the line. Differentiation, absolute continuity, Lp spaces, Fubini's theorem. If time permits, some applications to Fourier series and transforms. (Cook.)

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. (Timsans.)

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. (Kirwan.)

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 Lp, 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. (Gowen.)

MATH 290, 291. Lie Groups. (3, 3)
Prerequisites, MATH 022, 103, 104, 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. (Chu.)

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. (Wolfe.)

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. (G. Lehner.)

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. (Staff.)

MATH 399. Thesis Research. (Master's Level) (Arranged) (Staff.)

MATH 499. Dissertation Research. (Doctoral Level) (Arranged) (Staff.)

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, Lp spaces. Randon-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. (Staff.)

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.) (Staff.)

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. (Staff.)

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 erogodic theory. (Staff.)

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. (Staff.)

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. (Staff.)

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. (Staff.)

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. Unbaised tests and applications to normal families. (Staff.)

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 Hunt-Stein theorem. (Staff.)

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. (Staff.)

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. (Staff.)

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. (Staff.)

MECHANICAL ENGINEERING

Professors: Allen, Armstrong, Hsu, Jackson, Marcinkowski, Sayre, Shreeve, Talaat, and Weske.

Associate Professors: Anand, Asimow, Berger, Cunniff, Hayleck, John, Marks, Walston, Wockenfuss, and Yang.

Assistant Professors: Buckley, Elkins, Fourney, Morse, Sallet, Todeschini, 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 eighteen semester hours.

Registration for six credits of research (ENME 399, Research) for the M.S. degree and twelve credits for the Ph.D. 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.

For Advanced Undergraduates and Graduates

ENME 100. Thermodynamics. (3)

Two lectures and one laboratory period a week. Prerequisites, PHYS 031, MATH 021, concurrently. 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.
(Allen, Kraft, Owens.)

ENME 101. Dynamics of Machinery. (2)

One lecture and one laboratory period a week. Prerequisites, ENES 021, MATH 066 or ENME 116 concurrently. (Hayleck, Cunniff.)

ENME 102. Fluid Mechanics I. (3)

Two lectures and one laboratory period a week. Prerequisite, ENME 060. A rational study of fluids at rest and in motion. Principles of viscous and turbulent flow in pipes, nozzles, etc. Impulse and momentum. Pumps, turbines, and meters. Dimensional analysis and laws of similarity. (Sayre, Tsui.)

ENME 103. Materials Engineering. (3)

Two lectures and one laboratory period a week. Prerequisite, ENES 030. Processes and methods to manufacture and usefully apply engineering materials; 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.
(Armstrong, Asimow, Marcinkowski.)

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. (John.)

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. Analogy between the transfer of mass, heat, and momentum. (Hsu, Sallet, Walston.)

ENME 107. Energy Conversion. (3)
Three lectures a week. Prerequisite, 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. (Kraft, Owens.)

ENME 116. Applied Mathematics in Engineering. (3)
Prerequisite, MATH 021. Mathematical techniques applied to the analysis 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. (Yang, Walston.)

ENME 120. Measurements Laboratory. (2)
One lecture and one laboratory period a week. Prerequisites, ENES 030, ENME 101, and ENEE 060, ENME 106 concurrently. Required of juniors in Mechanical Engineering. Measurements and measurement systems; applications of selected instruments with emphasis on interpretation of results. (Tsui, North.)

ENME 140. Engineering Analysis and Computer Programming. (3)
Three lectures a week. Prerequisite, MATH 066 or ENME 116. Elements of operational calculus, vector analysis; numerical methods and programming for computers. Errors, interpolation, series, integration, iteration, and solution of equations. (Cunniff, Fourney.)

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. (Allen, Talaat.)

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 machinery. (Hayleck, Jackson.)

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. (Todeschini, Fourney.)

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. (Allen, Anand.)

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.
(Berger, Fisher, Sayre, Walston.)

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. (North.)

ENME 162. Dynamics II. (3)
Three lectures a week. Prerequisites, ENME 101, MATH 066 or 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. (Hayleck, Cunniff.)

ENME 163. Fluid Mechanics 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. (Buckley, John.)

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. (Allen, Shreeve.)

ENME 165. Automatic Controls. (3)
Three lectures per week. Prerequisites, ENEE 062, 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. (Anand, Walston.)

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. (Staff.)

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. (Jackson.)

ENME 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. (Armstrong, Asimow, Marcinkowski.)

ENME 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. (Armstrong, Asimow, Marcinkowski.)

ENME 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 emphasis on the relationships between structure of the solid and its potential engineering application. (Armstrong, Asimow, Marcinkowski.)

ENME 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.
(Armstrong, Asimow, Marcinkowski.)

For Graduates

ENME 200. Intermediate Dynamics. (3)
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. Application to mechanical engineering problems. (Cunniff)

ENME 201. Advanced Dynamics. (3)
Prerequisite, ENME 200. Dynamics of three-dimensional rigid body motion; application of Euler's angles to rigid body motion. Hamilton's equations. 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. (Cunniff)

ENME 202. Continuum Mechanics. (3)
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. (Berger, Yang.)

ENME 203. Linear Theory of Elasticity. (3)
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 anisotrophic materials. (Berger, Yang.)

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. (Shreeve, Allen.)

ENME 206, 207. Advanced Mechanical Engineering Design. (3, 3)
Prerequisite, ENME 200, 202. 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. (Jackson.)

ENME 208, 209. Design Of Turbomachinery. (3, 3)
First and second semesters. Prerequisite, ENME 151. Characteristics and design of turbines, pumps, compressors and torque convertors; cavitation, stall, and surge. (Shreeve.)

ENME 210, 211. Advanced Fluid Mechanics. (3, 3)
First and second semesters. Prerequisite, 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. (Sayre, Haberman.)

ENME 212. Linear Vibrations. (3)
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.
(Cunniff)

ENME 213. Non-Linear Vibrations. (3)
Prerequisite, ENME 212, Geometrical and numerical analyses of nonlinear systems. Stability, Limit cycles. Theory of bifurcations. Perturbation method. Periodic solutions. Oscillations in systems with several degrees of freedom. Asyptotic methods. Nonlinear resonance. Relaxation oscillations. Self-excited vibrations. (Cunniff)

ENME 214, 215. Stress Waves in Continuous Media. (3, 3)
First and second semesters. 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.
(Seigel, Cunniff.)

ENME 216, 217, Energy Conversion-Solid State. (3, 3)
First and second semesters. Prerequisite, ENME 151. Combustion, thermo-electric, thermionic, fuel cells, reactors, magnetohydrodynamics. Kinetics of reactions, fission and fusion. (Talaat, Shreeve.)

ENME 218, 219. Energy Conversions-Solid State. (3, 3)
First and second semesters. Prerequisite, ENME 151. Design parameters in chemical, nuclear and direct conversion systems for the production of power; weight, efficiency and radiation. (Talaat, Shreeve.)

ENME 220. Seminar.
Credit in accordance with work outlined by mechanical engineering staff. Prerequisite, graduate standing in mechanical engineering. (Staff.)

ENME 223, 224. Plasticity. (3, 3)
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.
(Yang.)

ENME 227. Non-Linear Elasticity. (3)
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 superimposed on a given finite strain, wave propogation and stability problems are considered. (Berger.)

ENME 228. Viscoelasticity. (3)
Prerequisite ENME 202. This course treats the behavior of solid materials which possess fluid characteristics. Included within this group are Green-Rivlin

hygrostaric meterials. The study of objective tensor rates and other invariance requirements leads to the formulation of constitutive equations for various visco-elastic materials. Steady shear flows, helical flow, visco-elastic torsion and problems arising from the linear viscoelastic theory are considered. (Berger.)

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 efficiency. 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. (Shreeve.)

ENME 231, 232. Advanced Heat Transfer. (3, 3)
First and second semesters. Three lectures a week. Prerequisites, ENME 150, ENME 151. Advanced problems covering effects of radiation, conduction, convection, evaporation and condensation. Study of research literature on heat transfer. (Shreeve, Allen.)

ENME 233, 234. Compressible Flow. (3, 3)
First and second semesters. Prerequisites, 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. (Sayre, Haberman.)

ENME 235, 236. Linear and Non-Linear Elastic Shells. (3, 3)
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 development 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. (Fourney, Todeschini.)

ENME 238. Advanced Topics in Mechanical Engineering. (2 or 3)
Prerequisite, consent of Instructor. Advanced topics of current interest in the various areas of Mechanical Engineering. May be taken for repeated credit. (Staff.)

ENME 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 ENAE 280, 281.) (John.)

ENME 282, 283. Special Topics in Unsteady Hydrodynamics. (3, 3)
First and second semesters. Prerequisite, 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 dams, 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 to solve practical problems. The use of high speed computers will be featured in numerical solutions wherever practicable. (Haberman.)

ENME 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 macroscopically measured properties to crystal symmetry. Structure aspects of defects in crystalline solids. (Armstrong, Asimow.)

ENME 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 optical properties of engineering solids. (Armstrong, Asimow.)

ENME 359. Special Topics in Structure of Engineering Materials. (3)
Prerequisite, consent of Instructor. (Staff.)

ENME 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. (Skolnick.)

ENME 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. (Bolsaitis.)

ENME 369. Special Topics in the Chemical Physics of Materials. (3)
Prerequisite, Consent of Instructor. (Staff.)

ENME 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. (Armstrong, Asimow, Marcinkowski.)

ENME 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. (Armstrong, Asimow.)

ENME 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. (Armstrong, Asimow.)

ENME 379. Special Topics in the Mechanical Behavior of Engineering Solids. (3)
Prerequisite, Consent of Instructor. (Staff.)

ENME 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.)

ENME 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. (Armstrong, Asimow, Marcinkowski.)

ENME 389. Special Topics in Experimental Techniques in Materials Science. (3)
Prerequisite, Consent of Instructor. (Staff.)

ENME 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, transformation in polymers, fabrication of polymers as to shape and internal structure.
(Armstrong, Asimow, Marcinkowski.)

ENME 391. Special Topics in Materials Technology. (3)
Prerequisite, Consent of Instructor. (Staff.)

ENME 397. Seminar in Engineering Materials. (1)
Discussion of current advances and research in engineering solids. (Staff.)

ENME 398. Special Problems in Engineering Materials.
Special study or investigation in Materials Science under the direction of an assigned faculty advisor. Credit variable and since content changes, re-registration is permissible. (Staff.)

ENME 399. Thesis Research in Mechanical Engineering. (Master's Level)
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. (Staff.)

ENME 499. Dissertation Research in Mechanical Engineering. (Doctoral Level)
(Staff.)

METEOROLOGY

Professors: Faller, Landsberg, and Fritz.
Assistant Professors: Gage, Rodenhuis, and Thompson.
Visiting Lecturer: McGovern.

This program offers a course of study leading to the degree of Master of Science and Doctor of Philosophy, and is open to students holding the Bachelor's degree in meteorology, chemistry, mathematics, physics, astronomy, engineering, or other programs with suitable emphasis in the sciences. Previous 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 faculty or by a faculty member of another appropriate department.

Examinations for Candidacy

The Preliminary Examination (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 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 sixteen (16) 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 Ph.D. 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. The minor program, 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)
Prerequisite, MATH 022 or equivalent and 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 in order to acquaint him with the interaction of the

physical and dynamical processes and the various scales of atmospheric phenomena. Some work in synoptic analysis and an introduction to methods of forecasting (e.g. subjective, numerical, statistical) is included.

METO 112. Physics and Thermodynamics of the Atmosphere. (3)
Prerequisite, MATH 022 or equivalent and 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.

For Graduates

METO 210. Dynamic Meteorology I. (3)
Prerequisite, MATH 111 or equivalent, METO 111 or equivalent. The equations of fluid motion; circulation and vorticity theorems; goestropic, cylostrophic and inertial motion; the thermal wind equations; boundary-layer flow; potential vorticity and the Rossby wave equation; perturbation theory and an introduction to atmospheric turbulence; the momentum and energy balance of the general circulation.

METO 211. Dynamic Meteorology II. (3)
Prerequisite, METO 210. Barotropic and baroclinic instability theories of the general circulation of the atmosphere; wave motions induced by topography and thermal assymetries; mountain waves, thermal convection, and other selected topics.

METO 212. Atmospheric Turbulence and Diffusion. (3)
Prerequisite, METO 210. 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; the theory of homogeneous turbulence; recent theories of turbulence shear flow and convection.

METO 214. Numerical Weather Prediction. (3)
Prerequisite, METO 211. Numerical techniques for the solution of partial differential equations; application to the equations of atmospheric motion; stability criteria; Eulerian, Lagrangian, and spectral methods; filtered and primitive equation models; numerical models of the general circulation; current applications to research and forecasting.

METO 220. Physical and Dynamical Oceanography. (3)
Prerequisite, consent of instructor. Physics of the ocean. Theories of wave and tidal motions. Applications of fluid dynamics to theories of the general circulation of the oceans. Thermal and dynamical interactions of the ocean and the atmosphere.

METO 230. Statistical Methods in Meteorology. (3)
Prerequisite, MATH 132 or equivalent, METO 211. Distribution of scalers and vectors; sampling methods; regression and correlation methods; tests of significance; time series analysis; statistical forecasting methods.

METO 240. Micrometeorology. (3)
Prerequisite, MATH 066 or equivalent. A study of energy balances at the earth-atmosphere interface statistical and spectral analysis of turbulence, turbulent transfer of energy and momentum, air motions in relation to terrain and landscape, the time and spatial cariations of mechanical and thermodynamical quantities in the micro-layer of the atmosphere.

Prerequisites, METO 110, 111 or equivalent. Review of basic macro and micrometeorological considerations; the nature and behavior of atmopsheric aerosols;

the description and measurement of the distribution, dispersion and other properties of air pollution; study of the meso-meteorology of cities and the climatological influences of air pollution.

METO 250, 251. Special Topics in Meteorology. (3, 3)

METO 254, 255. Seminar in Meteorology. (1, 1)

METO 399. Thesis Research. (Master's Level)
Original research and preparation of a thesis in partial fulfillment of the requirements for a master's degree.

METO 499 Dissertation. Research (Doctoral Level)

MICROBIOLOGY

Professors: Faber, Doetsch, Hansen, Hetrick, Laffer, and Pelczar.
Assistant Professors: Cook, MacQuillan, and Robertson.
Instructor: Vaituzis.
Lecturer: Stadtman.

The Department of Microbiology offers the degrees of Master of Science and Doctor of Philosophy.

The Department of Microbiology 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. (Roberson.)

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 equivalent. (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 microbiological problems under the supervision of a member of the Department. (Faber.)

For Graduates

MICB 201. Medical Mycology. (4)
First semester. Two lectures and two two-hour laboratory periods a week. Prerequisite, 30 credits in microbiology and allied fields. Primarily a study of the fungi associated with disease and practice in the methods of isolation and identification. (Laffer.)

MICB 202. Genetics of Microorganisms. (2)
Second semester. Two lecture periods a week. Prerequisite, consent of instructor. An introduction to genetic principles and methodology applicable to microorganisms. Spontaneous and induced mutations, interaction between clones. (Hansen.)

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. Characteristics and general properties of viruses and rickettsiae. Principles of tissue culture. (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 and tissue culture. (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)
Second 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. Seminar—Research Methods. (1)
First semester. (Staff.)

MICB 282. Seminar—Microbiological Literature. (1)
Second semester. (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: Ulrick, Bernstein, Gordon, Grentzer, and McCorkle.
Associate Professors: Berman (*Head*), Heim, Helm, Johnson, and Pennington.
Assistant Professors: Diemer and Montgomery.

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 statement of Departmental requirements supplementing those of the Graduate School has been formulated for each of the areas of specialization. Copies may be obtained by applying to the Department.

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

For Graduates and Advanced Undergraduates

MUSC 112, 113, 152, 153. Applied Music. (2, 2, 2, 2)
First and second semesters. Prerequisite, the next lower course on the same instrument. One hour lesson and six practice hours per week. The student will indicate the instrument chosen by adding the proper section number. (Staff.)

MUSC 120, 121. History of Music. (3, 3)
First and second semesters. Prerequisite, MUSC 001 or 020 and junior standing. (Bernstein and Helm.)

MUSC 141. Musical Form. (3)
First semester. Prerequisite, MUSC 070, 071. (Meyer.)

MUSC 143, 144. Composition. (2, 2)
First and second semesters. Prerequisite, MUSC 070, 071. (Staff.)

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. (Diemer.)

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. (Staff.)

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. (Diemer.)

MUSC 150. HARMONIC AND CONTRAPUNTAL PRACTICES OF THE TWENTIETH CENTURY. (2)
Prerequisite, MUSC 071 and 145. (Diemer.)

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. (Traver.)

MUSC 163. CONTEMPORARY MUSIC. (3)
Second semester. Prerequisite, MUSC 120, 121, or the equivalent. (Diemer.)

MUSC 164. SOLO VOCAL LITERATURE. (3)
Prerequisite, MUSC 120, 121 or the equivalent (Pennington.)

MUSC 165. KEYBOARD MUSIC. (3)
Prerequisite, MUSC 120, 121 or the equivalent. (Bernstein.)

MUSC 166. SURVEY OF THE OPERA. (3)
Second semester. Prerequisite, MUSC 120, 121 or the equivalent. (Helm.)

MUSC 167. SYMPHONIC MUSIC. (3)
First semester. Prerequisite, MUSC 120, 121 or the equivalent (Ulrich.)

MUSC 168. CHAMBER MUSIC. (3)
Second semester. Prerequisite, MUSC 120, 121 or the equivalent. (Ulrich.)

MUSC 169. CHORAL MUSIC. (3)
First semester. Prerequisite, MUSC 120, 121 or the equivalent. (Traver.)

MUSC 175. CANON AND FUGUE. (3)
Second semester. Prerequisite, MUSC 146 or the equivalent. (Staff.)

MUSC 180. ACOUSTICS FOR MUSICIANS. (3)
Second semester. Prerequisite, MUSC 071 or the equivalent, and senior or graduate standing in music. (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. (Staff.)

MUSC 185. MUSIC PEDAGOGY. (3)
Second semester. 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. (Staff.)

For Graduates

MUSC 200. ADVANCED STUDIES IN THE HISTORY OF MUSIC. (3)
First semester. Prerequisite, MUSC 120, 121, and consent of instructor. A criti-

cal 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)
Second semester. 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. (Staff.)

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. (Staff.)

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. (Staff.)

MUSC 209. Seminar in Musical Composition. (3)
Prerequisite, MUSC 144 or the equivalent, and graduate standing. An advanced course in musical compisition. May be repeated for credit. (Staff.)

MUSC 210. Factors in Musical Learning. (3)
Second semester. 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)
First semester. 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. (Staff.)

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 and Staff.)

MUSC 305. Doctoral Seminar in Music. (3)
First semester. 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. (Staff.)

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)
Research in theory or history and literature of music, and musical composition. May be repeated for credit. (Staff.)

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

PHILOSOPHY

Professor and Head: Schlaretzki.
Professor: Pasch.
Visiting Professor: Tranoy.[1]
Associate Professors: Brown, Celarier, Perkins.
Assistant Professors: Goldstone, Kress, Odell, Roelofs, Varnedoe, and Winslade.
Visiting Assistant Professor: Lesher.
Lecturer: Goodwin.

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] Spring semester, 1969

For Graduates and Advanced Undergraduates

PHIL 101. Ancient Philosophy. (3)
First and second semesters. Prerequisite, six hours in philosophy. (Celarier.)

PHIL 102. Modern Philosophy. (3)
First and second semesters. Prerequisite, six hours in philosophy. (Winslade.)

PHIL 103. Nineteenth Century Philosophy. (3)
Prerequisite, six hours in philosophy. (Staff.)

PHIL 104. Twentieth Century Philosophy. (3)
Prerequisite, six hours in philosophy. A survey of philosophy in the 20th century through a consideration of representative figures in England, Europe, and America. Among the theories to be studied are logical atomism (Russell, Wittgenstein), positivism (Carnap, Ayer), existentialism and phenomenology (Sartre, Husserl), naturalism and realism. (Dewey, Santayana). (Brown.)

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)
A critical and constructive philosophical examination of the assumptions, goals, and methods of contemporary democracy, facism, socialism, and communism, with special attention to the ideological conflict between the United States and the U.S.S.R. (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) (Staff.)

PHIL 154. Political and Social Philosophy. (3) (Goldstone, 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. (Staff.)

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.

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 judgments 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.

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.

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, Winslade.)

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, Odell, Pasch.)

PHIL 175. Topics in Symbolic Logic. (3)
Prerequisite, PHIL 155. May be repeated for credit when the topics dealt with are different. (Staff.)

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. (Staff.)

PHIL 180. THE PHILOSOPHY OF PLATO. (3)
Prerequisite, PHIL 101 and 102. (Celarier.)

PHIL 181. THE PHILOSOPHY OF ARISTOTLE. (3)
Prerequisite, PHIL 101 and 102. (Celarier.)

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. (Celarier.)

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. (Varnedoe.)

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: Fraley, Harvey, Humphrey, Husman, Johnson, Eyler.
Associate Professors: Clarke, Stull, Kramer, Steele, Kelly, Jones.

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, administration, 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, and PHED 200—Seminar in Physical Education, Recreation, and Health, and PHED 399—Research—Thesis.

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.
(Campbell, Nelson.)

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. Theory of Exercise. (3)
First and second semesters; summer session. Prerequisite, PHED 100. (Clarke.)

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 and Health. (3)
First and second semesters; summer session. Two lectures and two laboratory periods a week. (Kelley, Nessler.)

*A research project must be conducted in each 100 level course taken for graduate credit.

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. (Eyler.)

PHED 191. The Curriculum in Elementary School Physical Education. (3)
First and second semesters; summer session. Prerequisite, PHED 120.
(Humphrey.)

PHED 193. History and Philosophy of Sport and Physical Education. (3)
First and second semesters; summer session. (Staff.)

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. Foundations in Physical Education, Recreation and Health. (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, Recreation and Health. (3)
First and second semesters; summer session. (Alexander.)

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. (Husman.)

PHED 210. Methods and Techniques of Research. (3)
First and second semesters; summer session. (Clarke.)

PHED 215. Principles and Techniques of Evaluation. (3)
First and second semesters; summer session. (Staff.)

PHED 230. Source Material Survey. (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. Scientific Bases of Exercise. (3)
First and second semesters; summer session. (Staff.)

PHED 287. Advanced Seminar. (1-3)
First and second semesters; summer session. (Staff.)

PHED 288. Special Problems in Physical Education, Recreation and Health. (1-6)
First and second semesters; summer session. (Staff.)

PHED 290. Administrative Direction of Physical Education, Recreation and Health. (3)
First and second semesters; summer session. (Humphrey.)

PHED 291. Curriculum Construction in Physical Education and Health. (3)
First and second semesters; summer session. (Hanson.)

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. (Johnson.)

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 Second Schools. (2-6)
First and second semesters; summer session. (Johnson, 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. (Humphrey.)

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. (Clarke.)

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. (Jones.)

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. (Johnson.)

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. (Staff.)

HLTH 291. Curriculum Construction in Health Education. (3)
First and second semesters; summer session. (Staff.)

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. (Harvey.)

RECR 150. Camp Management. (3)
First and second semesters; summer session. (Harvey.)

RECR 180. Leadership Techniques and Practices. (3)
First and second semesters. (Harvey.)

RECR S184. Outdoor Education. (6)
Summer only. (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. (Harvey.)

For Graduates

RECR 200. Seminar in Physical Education, Recreation and Health. (1)
First and second semesters; summer session. (Staff.)

RECR 201. Foundations of Physical Education, Recreation and Health. (3)
First and second semesters; summer session. (Eyler.)

RECR 202. Philosophy of Recreation. (2)
First and second semesters; summer session. (Harvey.)

RECR 203. Supervisory Techniques in Physical Education, Recreation and Health. (3)
First and second semesters; summer session. (Pickett.)

RECR 204. Modern Trends in Recreation. (3)
First and second semesters; summer session. (Harvey.)

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. (Eyler.)

RECR 240. Industrial Recreation. (3)
First and second semesters; summer session. (Harvey.)

RECR 260. Hospital Recreation. (3)
First and second semesters; summer session. (Harvey.)

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. (Humphrey.)

RECR 399. Thesis Research. (Master's Level)
First and second semesters; summer session. (Staff.)

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

PHYSICS AND ASTRONOMY

(For Astronomy, Meteorology, and Institute for Molecular Physics (Chemical Physics), see Table of Contents)

Professors: Laster, Westerhout, Banerjee, Day, Erickson, Ferrell, Glasser,[1] Glover, Greenberg, Griem, Holmgren, Hornyak, Kerr, Krall, Kundu, Levinson, MacDonald, Marion, Misner, Myers, Oneda, Prange, Snow, Sucher, Trivelpiece, Wall, Weber, and Yodh.

Professors (part-time): Burgers,* Friedman, Hayward, Kolb, Levy, McDonald, Musen, Opik, Rado, Slawsky.

Research Professor: Benedict,** Benesch,** Elsasser,* Faller,*** Landsberg,*** Pai,* Tidman,* Vanderslice,** and Zwanzig.***

Visiting Professors (part-time): Escobar-V., and Levy.

Associate Professors: Alley, Bardasis, Beall, Bhagat, Brush,*[4] DeSilva, Dorfman,[4] Dragt, Earl, Falk, Fivel, Glick, Griffin, Kacser, Y. S. Kim, Koch, T. A. Matthews, Pati, Pugh, Reiser,[2] Rodberg, E. Smith, Steinberg, Wentzel, Woo, Zipoy, B. S. Zorn, and G. Zorn.

Research Associate Professors: DeRocco,** Guernsey,* Krisher,** Lashinsky,* D. L. Matthews,* Sengers,** *and* Wilkerson.*

Associate Professors (part-time): Bennett, and Dixon.

Assistant Professors: A'Hearn, Anderson, Beaglehole, Bell, Berg, Bettinger, R. A. Brandt, C. Y. Chang, Currie, Davidson, DiLavore,[3] Gloeckler, Greene, Greig, Harrington, H. G. Kim,[5] Korenman, Kunze, LaPointe, Leibowitz, Lenchek, Mead, Nolen, Pechacek, Poultney, Risk, Roos, Roush, Stephenson, Young, and Zapolsky.

Research Assistant Professors: Ginter,** Goldman,* Koopman,* Munn,** Spain,** and Verbeke.**

Visiting Assistant Professor: Edwards.

Research Associates: Bandermann, Chang, Colleraine, Connors, Dove, Drew, Goldberg, Goldenbaum, Hemingway, Herman,* Hinds, John-

STONE, KEPPLE, KOEHLER, MITTER, NAUGLE, NINIO, OSMUNDSON, PAYNE, PRINZ, RICHARD, SHARMA, S. SMITH, SVETLICHNY, SWANK, WAYLAND, AND WIHL.

Visiting Lecturers: ARMSTRONG, FICHTEL.

Part-time Lecturers: AITKEN, EISELE, GARSTENS, IVORY, KARLE, LICHT, LIDE, MAISCH, AND MEIRS.

PHYSICS

It is expected that the following areas should have been studied preliminary to graduate work. Any deficiencies should be made up at once. A limited amount of graduate credit will be allowed for courses so taken.

General Physics	Electricity and Magnetism
Thermodynamics	Modern Physics
Intermediate Mechanics	Advanced Calculus
Physical Optics	Vector Analysis

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 $2,700 for the academic year. Full-time summer research stipends for advanced graduate students are also available. Applicants for assistantships are automatically also considered as candidates for fellowships awarded by the Department, such as Center for Theoretical Physics Graduate Fellowships, 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 Park, Maryland 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 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 must 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 a minor in either astronomy, chemistry, chemical physics, mathematics, engineering, and/or in fields of physics other than their field of major specialization.

There is also a graduate program in Chemical Physics centered in the Institute

*Institute for Fluid Dynamics and Applied Mathematics.
**Institute of 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.

of Molecular Physics, with degrees either in Physics or the Chemistry Department.

THESIS (Ph.D.)

The student must submit an outline of his topic to the graduate faculty for approval. This outline must clearly set forth the nature of the problem, proposed method of procedure and the possible results that may be obtained. The completed thesis will also be presented to the graduate faculty for approval.

TIME LIMITS

There is a departmental limit on the time taken to get a graduate degree in physics or astronomy. For the M.S., this is five calendar years from the date of first enrolling in the Graduate School for full-time students and six years for part-time students. For the Ph.D., 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.

Graduate Assistants and other students whose employment is part-time and secondary to their studies are considered full-time students. Timing began on September 12, 1960 for those students who were enrolled in the Graduate School before that date.

OFF-CAMPUS COURSES

The Department of Physics and Astronomy 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 M.S. candidates must take at least 3 credits of their graduate work on the College Park campus; for the Ph.D. degree, students must complete on the College Park campus at least 18 credits. For the Ph.D. in physics, these credits must include at least 2 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 100-level courses at Maryland. Those students who are initially refused formal admission to the Graduate School may apply for admission to University College (off-campus program), or to the College of Arts and Sciences as special students.

Each such student should then take at least 12 credits of 100-level courses in physics and astronomy including, if possible, Physics 120 and Physics 122 or other comparable courses suggested by his advisor. At the completion of all of these courses with grades of "B" or better, the student should then reapply for admission to the Graduate School. While the credits earned in University College are not directly applicable toward a graduate degree, the student will find that the credit requirements are normally not the principal obstacle anyway in earning an advanced degree and the courses taken by registration in University College will form a good basis for later graduate study. The University of Maryland hopes in this way to offer an opportunity for advanced study in physics and astronomy to all qualified students.

FURTHER INFORMATION

For more information students should write to the Department of Physics and Astonomy for the departmental publication entitled "Graduate Study in Physics."

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 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. (Staff.)

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 021; MATH 021; (F. McDonald.)

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 or PHYS 128. (Bettinger.)

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 in-

tegral 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. (Beall.)

PHYS 119. Modern Physics. (3)
Each semester. Three lectures a week. Prerequisite, PHYS 118. (Stephenson.)

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. (Dragt.)

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. (Kim.)

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. (Armstrong.)

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. (Myers.)

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 021 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). (Kunge.)

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. (Zapolsky.)

PHYS 201. Statistical Physics. (3)
Each semester. Three lecture hours per week. Prerequisite, PHYS 127 or equivalent. Statistical mechanics, thermodynamics, kinetic theory. (Green.)

PHYS 202, 203. Advanced Dynamics. (2, 2)
First and second semesters. Two lectures a week. Prerequisite, PHYS 201. A detailed study of advanced classical mechanics. (Myers.)

PHYS 204. Methods of Mathematical Physics. (4)
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.)

PHYS 205. Electrodynamics. (3)
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. (Koch.)

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. (3, 4)
First and second semesters. Four lectures per week. Prerequisite, PHYS 201 or 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. (Hornyak, Fivel.)

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.

PHYS 240, 241. Theory of Sound and Vibrations. (3, 3)
Three lectures a week. Prerequisite, PHYS 201. 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 107 and MATH 021. 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.

Microcanonical, 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. (Brueckner.)

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. (Vanderslice.)

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. (Bhogot.)

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 213. Properties of metals, lattice vibrations and specific heats; Boltzmann, Fermi-Dirac, and Bose-Einstein statistics, free electron gas theories, band theory of metals. (Falk.)

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. (Bardasis.)

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. (Holmgren.)

For Graduates

PHYS 234, 235. Theoretical Nuclear Physics. (3, 3)
Three lectures a week. Prerequisites, PHYS 120 and PHYS 213. Nuclear properties and reactions, nuclear forces, two, three, and four body problems, nuclear spectroscopy, beta decay, and related topics. (Banerjee.)

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. (Pugh.)

E. ELEMENTARY PARTICLE PHYSICS

PHYS 239. Elementary Particles. (3)
Three lectures a week. Prerequisite, PHYS 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.)

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.)

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. (Sucher.)

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 and dynamics of the atmosphere.
(Lenchek, Bettinger.)

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. (Griem.)

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. (Krall.)

PHYS 224, 225. Supersonic Aerodynamics and Compressible Flow. (2,2)
Two lectures a week. Prerequisite, PHYS 201. (Pai.)

PHYS 226, 227. Theoretical Hydrodynamics. (3, 3)
Three lectures a week. Prerequisite, PHYS 201. A detailed study of advanced fluid dynamics. (Burgers.)

PHYS 232, 233. Hydromechanics Seminar. (1, 1)
First and second semesters. One meeting a week. (Staff.)

PHYS 246, 247. Special Topics in Fluid Dynamics. (2, 2)
Prerequisites, advanced graduate standing and consent of the instructor
(Burgers.)

PHYS 262, 263. Aerophysics. (3, 3)
Three lectures. Prerequisite, consent of the instructor. (Pai.)

H. GENERAL RELATIVITY

PHYS 236. Theory of Relativity. (3)
Three lectures a week. Prerequisite, PHYS 201. 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

PHYS 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. (Reiser.)

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 permis-

sion 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. (Greene.)

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 Combs.
Research Professor: Shorb.
Associate Professors: Creek, Godfrey, and Helbacka.
Assistant Professor: Pollard.

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.)

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) (Wills.)

Avian Anatomy, see Animal Science, 171. (3) (Wills.)

ANSC 109. Fundamentals of Nutrition. (3)
Second semester. Three lectures per week. Prerequisites, CHEM 031 and 033. This course will be for both graduate and undergraduate credit with additional assignments given to the graduate students. (Combs.)

ANSC 162. Avian Physiology. (2)
First semester. One lecture and one laboratory period per week. Prerequisites, ZOOL 001 and ZOOL 102 or equivalent. (Pollard.)

ANSC S163. Poultry Breeding and Feeding. (1)
Summer session only. This course is designed primarily for teachers of voca-

tional 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. (Combs.)

ANSC S164. Poultry Products and Marketing. (1)
Summer session only. This course is designed primarily for teachers of vocational agriculture and county agents. (Helbacka.)

ANSC 165. Physiology of Hatchability. (1)
Second semester. One, three-hour laboratory period per week. Prerequisite, ZOOL 102 or 104. (Shaffner.)

For Graduates

ANSC 221. Energy and Protein Nutrition. (3)
See An. Sci. for description. (Leffel, Combs.)

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. Prerequisites, ZOOL 102 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 263S. 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. (Combs.)

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. (Creek.)

ANSC 266. Physiological Genetics of Domestic Animals. (2)
Second semester. Two lectures per week. Prerequisites, ZOOL 006 and a course in 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 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 semester. 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, McGinnies, and Waldrop.
Associate Professors: Fisher, Fretz, Goldstein, Gollub, Hodos, Horton, Martin, McIntire, Pumroy, Steinman, Turnage, Vetter, Walder, and Ward.
Assistant Professors: Becker, Higgs, Johnson, Larkin, Locke, Scholnick, Smith, Sternheim, and Teitelbaum.

DEGREE REQUIREMENTS

For the master's degree a minimum of 30 hours is required. The *major,* composed of 21 hours, will be identified as *General Psychology* and will consist of PSYC 211-212 (6), PSYC 252-253 (6), the master's thesis research (6), and will consist of PSYC 252-253(6), the master's thesis research (6) and three courses (9) in core areas specified by the Department. The *Minor,* composed of a minimum of 9 hours, will ordinarily be taken in a field of specialization which the student proposes for the major in his doctoral program.

For the doctoral degree a minimum of 72 hours is required. The *majors,* composed of 48 hours, will consist of at least 30 hours in courses chosen from two specialized fields, and 18 hours of research for thesis, the last including 6 hours for the master's thesis. The *minor* will be in *General Psychology* and will consist of a total of 24 hours.

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 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. (McGinnies, Higgs, Ward.)

PSYC 123. Language and Social Communication. (3)
Second semester. Prerequisite, PSYC 021, senior standing and consent of instructor. (McGinnies, Higgs, Ward.)

PSYC 131. Abnormal Psychology. (3)
First and second semesters. Prerequisite, two courses in psychology including PSYC 005. (Staff.)

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. (Fisher, Steinman.)

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, Turnage, 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. (McGinnies, Higgs, Ward.)

PSYC 148. Psychology 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. (Staff.)

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, Bartlett, 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 161. Industrial Psychology. (3)
Prerequisite, 6 hours in psychology. A course designed to aid in the understanding of the problems of people in a variety of work situations; serving as an introduction to such technical problems as personnel selection interviewing, morale supervision and management, and human relations in industry. Lecture, discussion and laboratory. (Staff.)

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 sen-

sory phenomena, motor coordination, emotion, drives, and the neurological basis of learning. (Staff.)

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.)

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. (1-6)
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. (1-6)
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 folowing 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. Prerequisites, PSYC 180 and 211. The contemporary experimental and theoretical literature on selected problems in sensation and perception. (Fisher, Steinman.)

PSYC 203, 204. Graduate Seminar. (3, 3)
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 of research techniques and appartus; apparatus design and construction; telemetric and digital techniques; logical block circuitry. (Staff.)

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.)

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. (Staff.)

PSYC 223. Seminar in Community Mental Health. (3)
Selected problems in mental health psychology. (Staff.)

PSYC 224. Seminar in Student Personnel. (2)
Prerequisite, permission of instructor. The seminar is designed to acquaint the student with student personnel functions 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 presently engaged in student 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. (Fretz, Smith.)

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, environmental conditions and safety, occupational choice and classification, and the interview. (Bartlett, Goldstein, Locke.)

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 organizations as social structures, and the application of concepts and methods of social psychology to problems of conflict, cooperation, and leader-group relations. (Staff.)

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. (Staff.)

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. (McGinnies, 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. (McGinnies, 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. (Staff.)

PSYC 255. Seminar in Psychometric Theory. (3)
Prerequisite, PSYC 253. Study of psychophysical methods, scaling technique, 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.)

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.)

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, Walder.)

PSYC 263, 264. Modification of Human Behavior: Laboratory and Practicum. (3,3)
First and second semesters. Application of methods relevant to behavior change in conseling and psychotherapy. Individual supervision and group consultation.
(Pumroy.)

PSYC 265. Advanced Developmental Psychology. (3)
Empirical, experimental and theoretical literature related to developmental processes. (Pumroy, 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. (Walder, Vetter, Smith.)

PSYC 269. Practicum in Community Mental Health Consultation. (3)
Each year. Prerequisite, advanced standing. Directly supervised fieldwork in mental health consultation. (Staff.)

PSYC 270. Advanced Abnormal Psychology. (3)
Alternate years. Deviant behaviors and their etiology and taxonomy. (Vetter.)

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. (Maxwell.)

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

Associate Professor and Executive Secretary: Hirzel.
Associate Professor and Director of the Division of Anthropology: Williams.
Professor and Director of the Division of Criminology: Lejins.
Professors: Hoffsommer, Janes, and Lejins.
Associate Professors: Anderson, Cussler, Henkel, Hirzel, Hoffman, McIntyre, and Williams.
Assistant Professors: Coates, Federico, Frantz, Harper, Hunt, Pease, and Wilson.

The Department of Sociology grants the degrees of Master of Arts and Doctor of Philosophy. Fields of specialization include anthropology, criminology, rural and 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 sociolgy (including 6 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 Graduate and Advanced Undergraduates

Sociology 001 or its equivalent is prerequisite to all courses.

SOCY 102. Intercultural Sociology. (3) (Staff.)

SOCY 111. Sociology of Occupations and Careers. (3)
(Coates. Lengermann.)

SOCY 112. Rural-Urban Relations. (3) (Hoffsommer.)

SOCY 113. The Rural Community. (3) (Hoffsommer.)

SOCY 114. The City. (3) (Hirzel.)

SOCY 115. Industrial Sociology. (3) (Coates, Lengermann.)

SOCY 116. Military Sociology. (3) (Coates.)

SOCY 118. Community Organization. (3) (Federico.)

SOCY 121. Population. (3) (Hirzel.)

SOCY 122. Population. (3) (Hirzel.)

SOCY 123. Ethnic Minorities. (3) (Lejins.)

SOCY 131. Introduction to Social Service. (3) (Federico.)

SOCY 136. Sociology of Religion. (3) (Staff.)

SOCY 141. Sociology of Personality. (3) (Cussler, Hunt, Simons.)

SOCY 144. Collective Behavior. (3) (Cussler.)

SOCY 145. Social Control. (3) (Staff.)

SOCY 147. Sociology of Law. (3) (Lejins.)

SOCY 153. Juvenile Delinquency. (3) (Lejins, Wilson, Staff.)

SOCY 162. Social Stratification. (3)
The study of the nature of stratification; indicators of social class position; social class correlates; social class mobility; social class and society. (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.)

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. The student will select his particular area of interest and be responsible to an agency for a definite program of in-service training. Group meetings, individual conferences and written program reports will be a required part of the course. (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 candiates for the master's degree. (Henkel.)

SOCY 196. Introduction to Research Methods in Sociology. (3)
Nature and scope of sociological research, problem formulation, case study method, observational methods, survey method, experimental methods, documentary methods, miscellaneous methods. (Bateman, McIntyre, Staff.)

For Graduates

SOCY 201. Methods of Social Research. (3)
First semester. Selection and formulation of research projects; methods and techniques of sociological investigation and analysis. (Hoffsommer.)

SOCY 202. Advanced Research Methods in Sociology. (3)
Prerequisite, SOCY 201 or equivalent. Instruction in more advanced methodology in Sociological research. (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.
(McIntyre, Staff.)

SOCY 214. Survey of 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. (James, Hirzel, 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. (Staff.)

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.)

SOCY 221. Population and Society. (3)
Second semester. Selected problems in the field of population; quantitative and qualitative aspects; American and world problems. (Hirzel.)

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.)

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. (Pease.)

SOCY 253. Advanced Criminology. (3)
First semester. Survey of the principal issues in contemporary criminological theory and research. (Lejins.)

SOCY 254. Seminar: Criminology. (3)
Second semester. Selected problems in criminology. (Lejins.)

SOCY 255. Seminar: Juvenile Delinquency. (3)
First semester. Selected problems in the field of juvenile delinquency. (Lejins.)

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.)

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. (Staff.)

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. (Staff.)

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.)

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. (Janes, 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 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.)

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. (Anderson, Hoffman, Williams.)

ANTH 102. Cultural Anthropology: World Ethnography. (3)
Prerequisite, ANTH 001, 002 or 021. (Anderson, Hoffman, Williams.)

ANTH 114. Ethnology of Africa. (3)
Prerequisite, ANTH 001 and 002. (Staff.)

ANTH 123. Ethnology of the Southwest. (3)
Prerequisite, ANTH 001 and 002. (Anderson, Williams.)

ANTH 124. Ethnology of North America. (3)
Prerequisite, ANTH 001 and 002. (Hoffman.)

ANTH 126. Ethnology of Middle America. (3)
Prerequisite, ANTH 001 and 002. Cultural background and modern social, economic and religious life of Indian and mestizo groups in Mexico and Central America; processes of acculturation and currents in cultural development. (Williams.)

ANTH 131. Social Organization of Primitive Peoples. (3)
Prerequisite, ANTH 001 and 002. (Staff.)

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. (Staff.)

ANTH 151. Archeology of the New World. (3)
Prerequisite, ANTH 001 or 041. (Williams.)

ANTH 161. Advanced Physical Anthropology. (3)
Prerequisite, ANTH 001 or 061. A technical introduction to the hereditary morphological, physiological, and behavioral characteristics of man and his primate ancestors and relatives, with emphasis on evolutionary processes. (Staff.)

ANTH 171. Introduction Linguistics. (3) (Staff.)

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. (Hoffman.)

ANTH 281. Processes of Culture Change. (3)
Change in culture due to contact, diffusion, innovation, fusion, integration and cultural evoluation. (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 287A. 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 287B. Current Developments in Anthropology. (3)
Ethnohistory of the Eastern United States—Post-contact history of the Indian groups of the area in relation to patterns of European penetration and settlement. (Hoffman.)

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), Mendeloff, Parsons, Nemes, and Rand (*Emerita*).
Associate Professor: Rovner.

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 fields of Spanish. 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

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. Great Themes of the Hispanic Literatures. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. The evolution of the pervading themes of the Hispanic literatures, as reflected in representative manifestations across the ages. (Nemes.)

SPAN 107. Introduction to Medieval Literature. (3)
Prerequisite, SPAN 075. Spanish literary history from the eleventh through the fifteenth century. Selected readings from representative texts. (Staff.)

SPAN 111, 112. Prose and Poetry of the Sixteenth Century. (3, 3)
Prerequisite, SPAN 075. Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background. (Goodwyn, Staff.)

SPAN 113. Drama of the Sixteenth Century. (3)
Prerequisite, SPAN 075. 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)
Prerequisite, SPAN 075. An interpretive study of *Don Quixote* in connection with the other works of Cervantes and with the historical background. (Goodwyn.)

SPAN 117, 118. Prose and Poetry of the Seventeenth Century. (3, 3)
Prerequisite, SPAN 075. Selected readings, literary analysis, and discussion of the outstanding prose and poetry of the period, in the light of the historical background. (Goodwyn, Staff.)

SPAN 119, 120. Drama of the Seventeenth Century. (3, 3)
Prerequisite, SPAN 075. 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 decay of the Spanish theater. (Rovner.)

SPAN 125, 126. Literature of the Eighteenth Century. (3, 3)
Prerequisite, SPAN 075, 076, or 075, 078. 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)
Prerequisite, SPAN 075, 076, or 075, 078. Poetry, prose and drama of the Romantic period. (Gramberg.)

SPAN 131. Nineteenth Century Fiction. (3)
Prerequisite, SPAN 075, 076, or 075, 078. Significant novels of the nineteenth-century realistic movement. (Gramberg.)

SPAN 133, 134. Modernism and Post-Modernism in Spain and Spanish-America. (3, 3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. A study of the most important works and authors of both movements in Spain and Spanish America. (Nemes.)

SPAN 136. Modern Spanish Drama. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. Significant plays of the nineteenth and twentieth centuries. (Gramberg.)

SPAN 141, 142. The Generation of 1898 and Its Successors. (3, 3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. Authors and works of all genres of the generation of 1898 and those of the immediately succeeding generation. (Gramberg.)

SPAN 143. The Contemporary Spanish Novel. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. The novel and the short story from 1940 to the present. (Gramberg.)

SPAN 144. Contemporary Spanish Poetry. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. Spanish poetry from the Generation of 1927 to the present. (Gramberg.)

SPAN 159, 160. Spanish American Fiction. (3, 3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. Representative novels and/or short stories from the Wars of Independence to the present. (Nemes, staff.)

SPAN 162. Spanish-American Poetry. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. Main trends, authors and works from the Conquest to Ruben Dario. (Nemes.)

SPAN 163. Spanish-American Essay. (3)
Prerequisite, SPAN 075, 076, or 075, 078, or 077, 078. A study of the socio-political 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 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.)

SPAN 241, 242. The Twentieth Century. (3, 3)
Specific authors, genres and literary movements studied in depth. (Gramberg.)

SPAN 245. The Drama of the Twentieth Century. (3)
Specific authors and movements studied in depth. (Gramberg.)

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 for Minors in Peninsular Spanish Literature. (3, 3) (Staff.)

SPAN 283, 284. Reading Course for Minors in Spanish-American Literature. (3, 3) (Nemes, Staff.)

SPAN 291, 292. Open Seminar. (3, 3) (Staff.)

SPAN 399. Thesis Research. (Master's Level)
Credits determined by work accomplished. Guidance in the preparation of master's theses. Conferences. (Staff.)

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

SPEECH AND DRAMATIC ART

Professors: Strausbaugh, Aylward, Hendricks, and Pugliese.
Associate Professors: Baker, Landfield, Linkow, Meersman and Niemeyer.
Assistant Professors: Craven, Doudna, Kennicott, Kirkley, O'Leary, Provensen, Scher, Vaughan, Wolvin, and Zima.
Associate Research Professor: Causey.
Lecturer: Spuehler.

The Department offers a graduate course of study in the fields of dramatics, general speech, 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.

For Advanced Undergraduates and Graduates

SPCH 107. Advanced Oral Interpretation. (3)
Prerequisite, SPCH 013. (Provensen.)

SPCH 110. Advanced Group Discussion. (3)
Prerequisite, SPCH 010. Required in speech curriculum and elective in other curricula. (Linkow.)

SPCH 111. Seminar. (3)
Prerequisites, senior standing and consent of instructor. Present-day speech research. (Strausbaugh, Staff.)

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)
Second semester. Prerequisite, SPCH 002 or 011. (Wolvin.)

SPCH 163. Materials and Programs for the Development of Listening. (3)
Second semester. (Wolvin.)

SPCH 164. Persuasion in Speech. (3)
Second semester. Prerequisite, SPCH 002 or 011. (Schwartz.)

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)
First semester. (Landfield.)

SPCH 262. Special Problems in General Speech. (3)
First semester. (Zima.)

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)
Second semester. 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. (Zima.)

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)
Second semester. Prerequisite, DART 016 or consent of instructor. (O'Leary.)

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. (Landfield, O'Leary.)

DART 131. History of the Theatre. (3)
First semester. A survey of the dramatic production from early origin to 1800. (Niemeyer.)

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. (Landfield.)

DART 171. Styles and Theories of Acting. (3)
Second semester. Prerequisite DART 008 or consent of instructor. (Pugliese.)

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. (Waters.)

For Graduates

DART 270. Seminar: Studies in Theatre. (3)
First semester. Research projects adapted to individual backgrounds and special work. (Meersman.)

DART 271. The Theory of Pre-Modern Dramatic Production. (3)
Second semester. An historical survey of production styles. (Pugliese.)

DART 272. Special Problems in Drama. (3)
Second semester. 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 esthetics of theatre arts; and dramatic criticism. (Landfield.)

DART 275. Theory of Visual Design for the Performing Arts. (3)
Prerequisite, DART 175. A 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)
Second semester. Prerequisites, RATV 022 and consent of instructor. (Kirkley.)

RATV 115. Radio and Television in Retailing. (3)
First semester. Limited to students in the College of Home Economics. Prerequisite, SPCH 001 or 007. Writing and production of promotional programs for the merchandising of wearing apparel and home furnishings. Collaboration with the Washington and Baltimore radio stations and retail stores. (Kirkley.)

RATV 117. Radio and Television Continuity Writing. (3)
Second semester. Prerequisite, RATV 022 or consent of instructor. (Scher.)

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 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. Application will be made through crew assignments for University-produced television programs. (Staff.)

RATV 146. Television News and Public Affairs. (3)
First semester. Prerequisite, RATV 117 or JOUR 101. (McCleary.)

RATV 147. Analysis of Broadcasting Processes and Results. (3)
First semester. Prerequisite, RATV 022 or consent of instructor. (Scher.)

RATV 148. Television Direction. (3)
Two-hour lecture, three-hour laboratory. Prerequisites, RATV 022, 140. (Aylward.)

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. (2)
Second semester. Prerequisite, RATV 022 or consent of instructor. (Kirkley.)

RATV 151. Broadcast Programming and Criticism. (3)
Second semester. 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 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 familarized with basic cinematography, lighting, editing, pictorial composition and film continuity as a communication arts medium. (Staff.)

For Graduates

RATV 240. Seminar in Broadcasting. (3)
First semester. Studies of various aspects of broadcasting. (Aylward.)

RATV 241. Special Problems in Broadcasting. (3)
Second semester. An experimental laboratory course for the development of new ideas in broadcasting. (Scher.)

RATV 248. Advanced Television Direction. (3)
Second semester. Prerequiste, 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 Advanced Undergraduates and Graduates

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. (Craven.)

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. (Hendricks.)

SPHR 109. Speech and Language Development of Children. (3)
Second semester. Admission by consent of instructor. An analysis of normal and abnormal processes of speech and language development in children. (Hendricks.)

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)
First semester. Prerequisite, SPHR 105. A continuation of SPHR 105, with emphasis on the causes and treatment of organic speech disorders. (Staff.)

SPHR 126. Semantic Aspects of Speech in Human Relations. (3)
Second semester. Prerequisite, one course in public speaking. An analysis of speech and language habits from the standpoint of general semantics. (Hendricks.)

SPHR 135. Instrumentation in Speech and Hearing Science. (3)
First semester. 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. (Craven.)

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. (Craven.)

SPHR 141. Introduction to Audiometry. (3)
First semester. Prerequisite, SPHR 135. Analysis of various methods and procedures in evaluating hearing losses. Required for students whose concentration is in speech and hearing therapy. (Doudna.)

SPHR 142. Speech Reading and Auditory Training. (3)
Second semester. 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. (Doudna.)

For Graduates

The department maintains a reciprocal agreement with the Veterans Administration whereby clinical practice may be obtained at the Audiology and Speech Pathology Clinic, Veterans Administration Hospital, 50 Irving St., N. W., Washington, D. C.

SPHR 201. Special Problems Seminar. (A. through K.) (1, 3)
(6 hours applicable toward M.A. degree.) 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. (Hendricks, Staff.)

SPHR 202. Techniques of Research in Speech and Hearing. (3)
First semester. 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. (Staff.)

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. (Hendricks, Staff.)

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. (Hendricks.)

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. (Staff.)

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. (Staff.)

SPHR 211. A, B, C, D. Advanced Clinical Practice. (1, 3 up to 12)
(6 hours applicable toward M.A. degree.) 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. (Staff.)

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)
First semester. 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. (Doudna.)

SPHR 218. Speech and Hearing in Medical Rehabilitation and Special Education Programs. (3)
Second semester. Prerequisites, 6 hours in speech pathology and audiology and consent of instructor. Administrative problems involved in the organization and operation of speech and hearing theapy under the different types of programs. (Hendricks.)

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. (Hendricks.)

SPHR 220. Experimental Audiology. (3)
Second semester. 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 Hearing Problems. (3)
Second semester. 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. (Hendricks.)

SPHR 222. Advanced Bio-Acoustics. (3)
Prerequisite, 6 hours of audiology. Laboratory research methods in the study of hearing mechanisms in animals. (Spuehler.)

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. (Hendricks.)

SPHR 225. Advanced Semantics. (3)
Prerequisite, 3 hours of semantics. Advanced study of the effects of language in human perception. (Hendricks.)

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. (Staff.)

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. (Doudna.)

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. (Staff.)

VETERINARY SCIENCE

Director and Head: Ladson.
Associate Professors: Wills and Newman.
Assistant Professors: Albert, Mohanty and Schultz.

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.

For Graduates and Advanced Undergraduates

ANSC 116. Anatomy of Domestic Animals. (3)
First semester. One lecture and two laboratory periods per week. Prerequisite. ZOOL 001. (Albert.)

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

ANSC 119. Laboratory Animal Management. (3)
First semester. Two lectures and one laboratory period per week. Prerequisite, ZOOL 001. (Wills.)

ANSC 170. Poultry Hygiene. (3)
Second semester. Two lectures and one laboratory period per week. Prerequisites, MICB 001, and ANSC 001. (Newman.)

ANSC 171. Avian Anatomy. (3)
First semester. Two lectures and one laboratory per week. Prerequisite, ZOOL 001. (Newman.)

For Graduates

ANSC 200. Electron Microscopy. (3)
First and second semesters. One lecture and two laboratory periods per week. Theory of the electron microscope, preparation of specimens, manipulations and photography. (Mohanty.)

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 reporting the results in the form of a thesis. (Staff.)

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

ZOOLOGY

Professor and Acting Head: Jachowski.
Professors: Anastos, Brown, Grollman, Haley, Jachowski, Otto, and Schleidt.
Professor Emeritus: Burhoe.
Research Professors: Cronin,* Flyger,* and Koo*.
Associate Professors: Brinkley, Clark, Gainer, Highton, Linder, and Ramm.
Research Associate Professor, Part-Time: Eisenberg, and Price.
Assistant Professors: Contrera, Goode, Hailman, Imberski, Morse, Nelson, and Potter.
Research Associate: Doss.
Research Associate, Part-Time: Farr.
Lecturer: McIntosh.
Instructors: Kaufman, Moore, Nardell and Stewart.
Junior Instructors: Albert, Croshaw, Glover, Guidmore, Piper, Resau, Smith, and Vieweg.

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 M.S. and Ph.D. degrees are described earlier in the catalog.

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.

*Staff, Natural Resources Institute, University of Maryland

For further information and application forms, write to the Director of Graduate Studies, Department of Zoology, University of Maryland, College Park, Maryland, 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. A course in the biophysics of excitable cells, utilizing a fairly rigorous physical-chemical approach to the study of the mechanisms of action of such cells. (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. Genetic Systems. (3)
Three lectures a week. Prerequisites, a course in genetics, one year of organic chemistry and MATH 011 or equivalent. (Imberski.)

ZOOL 108. Animal Histology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisite, one year of zoology. (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.)
*Offered at the Chesapeake Biological Laboratory, Solomons, Maryland—summer only.

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 150. Special Problems in Zoology. (1 or 2)
Prerequisites, major in zoology or biological sciences, a minimum of 3.0 cumulative average in the biological sciences, and consent of instructor. Research or integrated reading in zoology. A student may register several times and receive up to 8 semester hours of credit. (Staff.)

ZOOL 151H. Honors Seminar. (1)
One discussion period a week. Prerequisite, participation in honors program. Guided discussion of topics of current interest. Repeatable to total of 4 hours credit. (Staff.)

ZOOL 152H. Honors Independent Study. (1-4)
Prerequisite, participation in honors program. Study of classical material by way of guided independent study and laboratory experiments. Repeatable to a total of 12 hours credit. (Staff.)

ZOOL 153H. Honors Research. (1-2)
Prerequisite, participation in honors program. A laboratory research problem which is required each semester during honors participation and culminates in an honors thesis. Repeatable to a total of 8 hours credit. (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. (Hailman.)

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.)

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; I. behavior; J. recent advances; K. endocrinology, and L. ecology. (Staff.)

ZOOL 208. Special Problems in Zoology. (Arranged)
A. cytology; B. embryology; C. fisheries; D. genetics; E. parasitology; F. physiology; G. systematics; I. behavior; J. general; K. endocrinology, and L. 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. Physiological Cytology. (4)
Two lectures and two three-hour laboratory periods a week. Prerequisites, one year of biochemistry and physics, a course in physiology, or permission of the instructor. A study of the structure and function of cells by chemical, physical and microscopic methods. (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 found 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)
Three lectures a week. Prerequisite, a course in physiology. Advanced study of the functioning of the organs of mammalian species. (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 project only. A. cytology; B. embryology; C. fisheries; D. genetics; E. parasitology; F. physiology; G. systematics; I. behavior; J. invertebrate zoology; K. endocrinology; L. ecology. (Staff.)

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

SCHOOL OF DENTISTRY

ANATOMY

Professors: Hahn and Piavis.
Associate Professor: Sinnreich.
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 MS or PhD degrees must be approved by the Graduate Admissions Committee of the School of Dentistry. Applicants are expected to have sound aca-

demic 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, demonstrations, 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, Sinnreich, 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, Sinnreich, 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, Sinnreich, Sachs.)

ANAT 212. Human Neuroanatomy. (2)
Same as ANAT 112 but with additional instruction of a more advanced nature.
(Hahn, Piavis, Sinnreich, 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, Sinnreich, Sachs.)

ANAT 399. Thesis Research. (Master's Level)
(Credit by arrangement.) (Staff.)

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

BIOCHEMISTRY

Associate Professor: Ganis.
Assistant Professors: Leonard and Morris.
Instructor: Courtade.

BIOCHEM 111. Principles of Biochemistry. (6)
Prerequisites, inorganic and organic chemistry, with additional training in quantitative and physical chemistry desirable. Two lectures and one laboratory period a week throughout the year, with one conference period per week during the first eight weeks of Semester 1. The chemistry of living matter forms the basis of the course. The detailed subject matter includes the chemistry of carbohydrates, fats, proteins, enzymes, vitamins, and hormones. The processes

of respiration, digestion, metabolism, secretion and excretion are considered. Laboratory instruction in qualitative blood and urine examination is included. (Ganis, Leonard, Morris, Courtade.)

For Graduates

BIOCHEM 211. Advanced Biochemistry. (6)
This course is the same as BIOCHEM 111 except that it includes additional instruction, collateral reading and assigned reports of an advanced nature. (Ganis, Leonard, Morris, Courtade.)

BIOCHEM 399. Thesis Research. (Master's Level)
(Ganis, Leonard, Morris, Courtade.)

BIOCHEM 499. Dissertation Research. (Doctoral Level)

HISTOLOGY

Professor: Provenza.
Associate Professors: Barry and Fischlschweiger.

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. (Barry, Fischlschweiger, Provenza.)

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.
(Barry, Fischlschweiger, Provenza.)

HISTOL 213. Mammalian Oral Histology aknd 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.
(Barry, Fischlschweiger, Provenza.)

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. (Provenza.)

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.
(Provenza.)

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. (Provenza.)

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. (Barry.)

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. (Barry.)

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) (Staff.)

MICROBIOLOGY

Professor: Shay.
Assistant Professors: Delisle, Joseph, Krywolap, and Schneider.

The Department of Microbiology serves both the School of Dentistry and the School of Pharmacy 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 and mycology.

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 hypersensitivity 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. (Shay.)

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. (Shay.)

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. (Shay.)

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. (Shay, Krywolap, Schneider.)

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 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.)

PATHOLOGY

Professors: J. J. Salley, and M. Lunin.
Associate Professor: W. Collett.
Assistant Professors: T. Beckerman, and B. S. Burch.
Instructor: E. Levin.

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 examination. (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.)

PHYSIOLOGY

Professor: White.
Associate Professor: Weatherred.

Physiology 121. F.S. Principles of Physiology. (4, 2)
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. (4, 2)
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 during the second semester. (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: O'Morchoe and Wadsworth.
Assistant Professors: Donati, Petersen, Ramsay, and Rennels.

The graduate degrees offered by the Department of Anatomy are the Doctor of Philosophy and the combined MD-Ph.D.

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 206. Correlative Anatomy. (1, 1)
Patients will be demonstrated and the anatomical features of the case will be stressed to give the student a concept of the relationship of the anatomy to clinical subjects.

ANAT 207. Fetal and Infant Anatomy. (2)
First semester, fifteen periods of three hours each, to be arranged. This course is open to graduate students and postgraduates interested in pediatrics. (Krahl.)

ANAT 211. Seminar. (1, 1)
First and 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 399. Research in Anatomy. (Master's Level)
Maximum credits, 12 per semester. Research work may be taken in any one of the branches of anatomy. (Figge, Staff.)

ANAT 499. Research in Anatomy. (Doctoral Level) (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)
This 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 208. Studies on Normal and Atypical Growth. (2)
Lectures in problems of growth. Two hours per week, time to be arranged. Sixteen weeks. (Figge.)

MICROANAT 399. Thesis Research. (Master's Level)
Maximum credits 12. Research work may be taken in any one of the branches which form the subject of microanatomy (including cancer research).
(Figge, Staff.)

MICROANAT 499. Dissertation Research. (Doctoral Level)

NEUROANATOMY

ANAT 203. Neurological Sciences. (4)
First and second semesters. 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, Wells.)

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 399. Thesis Research in Neuroanatomy. (Master's Level)
Maximum credits, 12. Research work involving the central or peripheral nervous system. (Figge, Staff.)

NEUROANAT 499. Dissertation Research in Neuroanatomy. (Doctoral Level)

BIOLOGICAL CHEMISTRY

Professors: Adams and Bessman (P.T.).
Associate Professors: Frank and Pomerantz
Assistant Professors: Bode, Gryder, Kirtley and Layne (P.T.).
Instructor: Brown.

Graduate degree offered by the Department of Biological Chemistry is the Doctor of Philosophy.

For Graduates

BIOCHEM 201. Principles of Biochemistry. (8)
First year, second semester. A general introduction to biochemistry with emphasis on basic chemistry of biologically important molecules, enzymes, intermediary metabolism, matabolic regulation, and molecular biology. Features of mammalian biochemistry are stressed but general and comparative aspects are considered. This is the biochemistry portion of a combined course in Biochemistry, Biophysics and Physiology, offered to first year medical students and interested graduate students. Graduate students may take only the Biochemistry section (approximately 50 lectures and 30 laboratory hours) or add the Biophysics section (consisting of about 25 lectures and 2 laboratory exercises) for additional credit.

BIOCHEM 202, 203. Special Topics in Biochemistry. (2, 2)
A series of lectures on special topics of current interest in biochemistry. Coverage varies from year to year and is amended annually. Topics in past years have included nucleic acid biochemistry, chromosomal structure, oxygenases, collagen biochemistry, peptide hormones, comparative biochemistry, metabolic regulation, protein synthesis, enzyme kinetics and mechanism. Single topics occupying varying periods from several weeks to an entire semester. Prerequisite, BIOCHEM 201 or equivalent.

BIOCHEM 204, 205. Seminar. (1, 1)
Reports on current literature or on research in progress. Prerequisite, BIOCHEM 201.

BIOCHEM 399. Thesis Research. (Maximum credits, 12 hours per semester.) (Master's Level)

BIOCHEM 499. Dissertation Research. (Doctoral Level)

MICROBIOLOGY

Professors: Wisseman, Traub.
Associate Professors: Eylar, Fiset, and Kessel.
Assistant Professors: Myers, Rosenzweig, and Snyder.
Instructors: Fabrikant, Hatgi.

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 Ph.D. degree. This Department encourages students who wish to enroll in the combined M.D.-Ph.D. 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. (Wisseman, 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. (Wisseman, 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. Prerequisites: MICB 201 or equivalent.
(Eylar, Fiset, Wisseman, Staff.)

MICB 211. Virology and Rickettsiology Laboratory. (1)
This course is the laboratory counterpart of MICB 210. It is designed to familiarize the student with the major techniques for the study of virus and rickettsial agents and to give him first hand experience with a variety of the more common agents. Registration is by permission of instructor only. Because of the limited facilities and the nature of the work, it may be necessary to restrict registration in this course according to the following priority: students majoring in medical microbiology, then students minoring in microbiology and, finally, others. The laboratory consists of two formal sessions per week; however, the nature of the work frequently requires additional participation throughout the week. (Eylar, Fiset, Wisseman, Staff.)

MICB 399. Thesis Research. (Master's Level)
Maximum credits, 12 hours per semester. (Wisseman, Staff.)

MICB 499 Dissertation Research. (Doctoral Level)

BIOPHYSICS

Professors: Mullins (*Chairman of Department*), and Sjodin.
Assistant Professor: 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 100, 101. Introduction to Biophysics. (3, 3)
Fall semester, odd years; Spring semester, even years. 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 102. 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 103. Laboratory Techniques in Biophysics. (3)
One lecture and two laboratory periods a week. Prerequisites, BIOPHYS 100, 101, 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 104. Seminar in Biophysics. (1)
Prerequisites, BIOPHYS 100, 101, or consent of the staff. Seminars on various biophysical topics given by the staff, graduate students, and guest speakers. (Staff.)

For Graduates

BIOPHYS 200. Advanced and Theoretical Biophysics. (3)
Fall semester, odd years. Three lectures a week. Prerequisites, BIOPHYS 100, 101, or consent of staff. An advanced and critical analysis of experimental findings in terms of biophysical theory. (Staff.)

BIOPHYS 201. 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 202. Biophysical Chemistry. (3)
Three lectures a week. Prerequisites, Physical Chemistry, Differential and Integral Calculus. The application of physico-chemical theory to the methods used to study the properties or proteins, nucleic acids, and other macromolecules and their component parts, and the properties of the fibers and other biological fabrics derived from these macromolecules. The properties of interest will include molecular weight, size, shape and charge, intramolecular configuration, and inter-molecular interaction. The methods of interest will include light scattering, ultracentrifuge, viscosity and other hydrodynamic methods, optical rotation and rotary dispersion. (Staff.)

BIOPHYS 203. 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 205. 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 399. Thesis Research in Biophysics. (Master's Level)
Required of students planning to take the Master of Science degree or the Doctor of Philosophy degree in Biophysics. (Staff.)

BIOPHYS 499. Dissertation Research in Biophysics. (Doctoral Level) (Staff.)

CELL BIOLOGY AND PHARMACOLOGY

Professors: Aposhian and Truitt.
Associate Professors: Dupraw and O'Neill.
Assistant Professors: Rudo.

All students majoring in the Department of Cell Biology and Phamacology with a view to obtaining the degree of Doctor of Philosophy should secure special 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, DuPraw, O'Neill, and Rudo.)

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, DuPraw, O'Neill, and Rudo.)

PHARMACOL 206, f.s. Pharmacologic Methodology. (4)
Prerequisite, PHARMACOL 201, f.s. (Truitt.)

PHARMACOL 207, 208. Chemical Aspects of Pharmacodynamics. (2, 2)
(Staff.)

PHARMACOL 209. Biochemical Pharmacology. (2) (O'Neill.)

PHARMACOL 210. History of Pharmacology. (2)
(Staff.)

PHARMACOL 399. Thesis Research. (Master's Level)
Maximum credits, 12. Credit in accordance with the amount of work accomplished. (Aposhian, DuPraw, O'Neill, and Rudo.)

PHARMACOL 499. Dissertation Research. (Doctoral Level)

LEGAL MEDICINE

Professor: Fisher.
Associate Professor: Freimuth.
Assistant Professor: Spitz.

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 202. Toxicology. (10)
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 203. Gross Pathologic Anatomy as Related to Toxicology. (2) 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)

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 general 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, 202, 203 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, 202, 203, 399.
PHARM 201 f. s., PHYSIOL 102, 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, Maryland.

PHYSIOLOGY

Professors: Blake and Barraclough.
Associate Professors: Adelman, Glaser, Karpeles, Merlis, and Pinter.
Assistant Professors: Fajer, Goldman, Greisman, and Jurf.

There are three graduate programs available to students interested in physiology: (1) a predoctoral program leading to the Ph.D. degree; (2) a predoctoral program leading to the Ph.D. degree with specialization in gerontology; and (3) a seven year predoctoral program leading to both M.D. and Ph.D. degrees. Prerequisites include differential and integral calculus, general physics, physical chemistry and comparative anatomy, although one of these may be taken concurrent with the first year of the predoctoral Ph.D. 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 203. Pulmonary Physiology. (2)
Two hours a week for 15 weeks. Reading assignments, lectures, seminars on current research in pulmonary physiology. (Staff.)

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. (Blake.)

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 211. Sensory Physiology. (3)
Two hours lecture and conference, one laboratory period a week for 15 weeks on sensory systems. (Merlis.)

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

NURSING ADMINISTRATION

GENERAL PSYCHIATRIC NURSING

NURSING OF CHILDREN WITH PSYCHIATRIC DISORDERS

MATERNAL AND CHILD NURSING

MEDICAL AND SURGICAL NURSING

PUBLIC HEALTH NURSING

Professors: Murphy and Cohelan.
Associate Professors: Borlick, Hosfeld, Hydorn, Kohl, MacVicar, Neal, and Reed.

MAJOR OBJECTIVES OF THE GRADUATE PROGRAM

The graduate program in nursing, leading to the Master of Science degree, is designed to prepare qualified professional nurses for positions of leadership as clinical specialists, teachers, or supervisors in the following clinical areas: general psychiatric nursing, nursing of children with psychiatric disorders, medical and surgical nursing, maternal and child nursing and public health nursing. A program in Administration of Nursing is available for those who wish to prepare for leadership positions in the administration of either nursing service or nursing education.

REQUIREMENTS FOR ADMISSION. 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. The applicant must have completed basic college or university courses in the physical and natural sciences (i.e., Chemistry, Microbiology, Anatomy and Physiology); and in the behavioral sciences (i.e., Psychology, Sociology and Anthropology). In addition, the applicant must have had clinical experience in Medical and Surgical Nursing, Psychiatric Nursing, Maternal and Child Nursing and Public Health Nursing comparable to the requirements in the basic undergraduate program in nursing at the University of Maryland.

LEARNING EXPERIENCE. Like graduate education in general, graduate study in nursing should facilitate the maturing of the individual, the extension of professional competence, and the enhancement of ability to contribute to knowledge. The graduate student is given opportunity to learn to pursue, evaluate, and apply results of research in nursing in order to find better ways of improving patient care. The graduate program assists the student to become

increasingly aware of the responsibilities of the nurse for the health of individuals in the community, the state, the nation, and the world.

The extensive clinical facilities of the University of Maryland and associated instiutions provide a multi-discipline climate for learning. Seminars, workshops, institutes and conferences also provide opportunities for extending the scope of the graduate student's understanding of nursing in a dynamic society.

Students in all clinical majors who elect preparation for the role of teacher, supervisor or clinical specialist receive practice in the functional area under faculty guidance.

A minimum of 8 semester hours must be devoted to a minor field. By definition these credits must comprise a group of coherent courses intended to supplement and support the major work. If the undergraduate work has not included a course in statistics, the student is expected to include a course in statistics in the first semester of the graduate program. At least ½ of the semester hours must be taken in courses numbered in the catalog as 200 or above.

Students may choose either the thesis-option or the non-thesis option.

THESIS OPTION. At thesis representing research in the major field must be approved by the student's advisor and presented to the Dean of the Graduate School as a partial requirement for the Master of Science degree. Final approval of the thesis is given by the examination committee appointed by the Dean of the Graduate School.

NON-THESIS OPTION. Two seminar papers may be submitted instead of a thesis. These papers must be approved by the student's advisor and must give evidence of independent study and scholarly writing ability. A final comprehensive examination must also be written.

For Graduates

NURS 201. Trends of Higher Education in Nursing. (2)
First semester, The central objective of this course is to bring to the student in nursing education a knowledge and an understanding of the current status of nursing in institutions of higher learning and what nursing must have as a goal before it can become a universally accepted profession. (Murphy.)

NURS 202. Interpersonal Interaction. (2)
First semester. One lecture and one two-hour laboratory period a week. The course is primarily concerned with the application of psychodynamics and psychoanalytic understandings to the nurses' relationships with patients. (Staff.)

NURS 203. Intradisciplinary Nursing. (2)
Second semester. This course is planned to provide increased ability in appreciation of mental health concepts to the nursing care of patients in all clinical areas. (Cohelan.)

NURS 204, 205. Psychiatric Nursing. (2, 2)
First and second semesters. One lecture and two four-hour laboratory periods a week. The course includes dynamics of human behavior, including formation of personality, the techniques of problem solving and the skills of communication in relation to therapeutic nursing care of psychiatric patients.
(Cohelan and Staff.)

NURS 206. Philosophical Concepts in Health-Epidemiology. (2)
Second semester. Two-hour lecture a week. The course is planned with a contemporary approach to the problem of epidemiological concepts in health.

The discussions begin with general considerations and progress to the application of these concepts to more specific situations. (Henderson, Borlick.)

NURS 207, 208. Nursing in Child Health Services. (2. 2)
First and second semesters. One lecture and two four-hour laboratory periods a week. This course is concerned with extensive knowledge and understanding of the place of nursing in the society's total program of child health services and increased skill in the nursing of children. (Reed.)

NURS 209, 210. Nursing in Maternal and Newborn Services. (2, 2)
First and second semester, one lecture and two four-hour laboratory periods a week. This course is concerned with extensive knowledge and understanding of maternal care and the opportunity to make application in varying nursing situations which relate to the patient, to the family and to the community. (Hydorn.)

NURS 211. Seminar in Maternal and Child Health Services. (2)
Second semester. One two-hour period a week. This course is concerned with understanding and purposeful application of maternal and child health nursing as it normally exists within the family. The influence of the nurse on maternal and child health is traced through the many institutions and agencies where she contacts the mother and child, or the family as a whole. (Hydorn, Reed.)

NURS 212, 213. Medical and Surgical Nursing. (2, 2)
First and second semester. One lecture and two four-hour laboratory periods a week. NURS 212 is available during the Fall Semester and is prerequisite to NURS 213 which is available during the Spring Semester. The selected course activities are arranged by each student and a teacher to comprise a program of study which will best prepare the student for the purposive improvement of medical and surgical nursing practice. (Hosfeld, Staff.)

NURS 220. 221. Public Health Nursing. (2, 2)
First and second semesters. One lecture and two four-hour laboratory periods a week. This course is designed to extend knowledge, understanding, and competencies of the nurse at the master's level in comprehensive public health nursing, including total planning to meet health needs of individuals and families in the community. Learning experiences will include selected clinical observations and participation in public health nursing, selected activities such as community health conferences, and interdisciplinary health consultations in a variety of community health settings. (Borlick, Staff.)

NURS 222. Public Health Administration. (2)
Second semester. Two-hour lecture a week. This course is designed to extend knowledge and understanding of the nurse at the Master's level of the principles of organization and administration of public health services, including budgeting, program planning, coordination, interpersonal relationships, and medical care practices, so as to increase the competencies of practice in teaching or supervising public health nursing. (Borlick, Beard.)

NURS 231. Scientific Basis of Maternal and Child Nursing. (2)
First semester. One two-hour period a week. A core of information common to maternal and child nursing consisting of lectures by experts in medicine and in physical and social sciences. Concurrent enrollment in NURS 207 or 209 is required. (Hydorn, Neal.)

NURS 247. Orientation to Critical Problems in Family-Child Relationships I. (2)
First semester. A seminar limited to those students who plan to specialize in child psychiatric nursing. Problems of children and their families in the cur-

rent society are examined with emphasis on normal and abnormal developmental crisis or age-level behavior. Findings of social and behavioral sciences are explored and related to the practice of child psychiatric nursing. Theories of Spitz, Bowlby, Erikson. Caplan, White and A. Freud are included. (McDonagh, Staff.)

NURS 248. Orientation to Critical Problems in Family-Child Relationships II. (2)
Second semester. Prerequisite: NURS 247. One two-hour period a week. A continuation of seminar study of family-child relationships in a current society with implications for the child psychiatric nurse. Theories of Josselyn, Fraiberg, Ackerman, Hartmann and Rappaport are included. (Staff.)

NURS 250. Comprehensive Nursing of Children with Psychiatric Disorders. (4)
First Semester. Two two-hour lectures and four four-hour laboratory periods a week. Prerequisite, NURS 202—Interpersonal Interaction. (2) and NURS 204-205—Psychiatric Nursing. (2, 2)
This course includes planning and implementation of nursing care of children who are mentally ill and who are receiving intensive care in a residential treatment center. Learning experiences include seminars in psychodynamic theory of mental illness of children, intensive nursing—child relationships, working as a member of a psychiatric interdisciplinary team, establishing, maintaining, and providing continuity of therapeutic relationships in the home setting with families of the children who are receiving treatment. (Thompson, Staff.)

NURS 251. Nursing of Pre-School Children with Deviate Behavior. (4)
Second Semester. Two two-hour lectures and four four-hour laboratory periods a week. Prerequisite, NURS 250—Comprehensive Nursing of Children with Psychiatric Disorders (4). This course includes guided observation and participation with individual and groups of disturbed pre-school children who attend the Children's Guild, Inc. Learning experiences include participation in psychological consultations and staff conferences, analysis and evaluation of problems of individual children and group therapy. Each student receives individual guidance throughout the course. (Thompson, Kanner.)

NURS 285. Curriculum Development in Nursing. (2)
First Semester. Two hour lecture a week. Prerequisite, PSYCH 110—Educational Psychology (3) or its equivalent. This course is designed to assist the student in curriculum planning, improvement, and evaluation including the formulation of objectives and the selection and organization of content and learning activities in nursing education. (Marriott, Hovet.)

NURS 286. Research Methods and Materials in Nursing. (2)
First Semester. One two-hour lecture or conference period a week. The course deals with basic understandings of philosophical aspects as they relate to research, including the nature of scientific thinking, methods of research, and research literature in nursing. (Cohelan, Staff.)

NURS 287. Seminar in Nursing—Administration, Teaching, Supervision. (2)
Third Semester. The purpose of this course is to develop the knowledge, understanding, and skill necessary to function in one of the above areas of nursing practice. (Staff.)

NURS 288S. Special Problems in Nursing. (1-6)
Prerequisites, NURS 204-205; or NURS 207-208; or NURS 209-210. The major objective of this course is to develop further clinical and research competencies in selected students who have completed a graduate core of clinical nursing. Registration upon consent of adviser. (Staff.)

NURS 289. Process of Administration. (3)
First semester. Study of the process of administration and its application to nursing situations; current concepts of organizational theory and behavior; examination of related research. (MacVicar.)

NURS 290. Administration of Nursing. (3, 3)
The purpose of this course is to provide opportunities for professional nurses to gain competence in administration of nursing through planned study and directed experience. This course extends over two semesters and deals with problems applicable to administration of services or education.
In the second semester, students in administration of nursing service and of nursing education will meet in separate sections part of the time in order to achieve greater depth in the respective areas. (MacVicar, Staff.)

NURS 291. Practicum in Administration. (4)
Third semester. The systematic investigation of a problem in administration of nursing. Individualized. Student has the opportunity to synthesize learning by working through a practical problem in the field. (MacVicar.)

NURS 399. Thesis Research. (1-6)
(Staff.)

SCHOOL OF PHARMACY

PHARMACY

Associate Professors: Shangraw, Lamy, and Allen.

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.

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 Administration I.
First semester. Two lectures. Prerequisite, PHARMACY 044. (Lamy.)

PHARMACY 158. Hospital Pharmacy Administration II.
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. (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.
(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.)

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. (Lamy.)

PHARMACY 231, 232. Special Problems in Pharmaceutical Technology. (2, 2)
Two laboratories. A study of technical problems in the stabilization and preservation of pharmaceuticals and the various methods of compounding special prescriptions. (Allen.)

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.)

PHARMACEUTICAL CHEMISTRY

Associate Professors: Leslie and Zenker.
Assistant Professors: G. Wright, and J. Wright.

The Department of Pharmaceutical 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 pharmaceutical 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

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.)

PHARM. CHEM. 149. Principles of Biochemistry. (5)
Four lectures and one laboratory. Prerequisites, PHARM CHEM 032, 034. Lectures and laboratory exercises devoted to the composition of living organisms and the chemical and physical processes which occur during health and in disease. (Zenker.)

PHARM. CHEM. 151, 152. Chemistry of Medicinal Products. (3, 3)
Three lectures. Prerequisite, PHARM 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 physio-chemical principles, and acquaint the student with precision apparatus. (Leslie.)

For Graduates

PHARM. 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 identififfication of organic structures by chemical and instrumental methods, to the synthesis of organic structures of the more difficult types including isotopically labeled compounds and to isotope counting techniques. (Staff.)

PHARM. CHEM. 230. Seminar. (1)
Each semester. Required of students majoring in pharmaceutical chemistry. Reports of progress and survey of recent developments in chemistry. (Staff.)

PHARM. CHEM. 235. Principles of Stereochemistry. (2)
Two lectures. Prerequisite, CHEM 141, 143. A study of the principles of stereo-chemistry of organic compounds. (G. Wright and J. Wright.)

PHARM. 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.)

PHARM. CHEM. 271. Biophysical Chemistry. (2)
Two lectures. Prerequisite, PHARM. CHEM. 149, CHEM 189. The application of physical chemical principles to biological systems, and a discussion of the physical properties of biologically important macromolecules. (Leslie.)

PHARM. 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.)

PHARM. 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.)

PHARM. CHEM. 281. Metabolic Inhibitors. (2)
Two lectures. Prerequisite, PHARM. CHEM. 149. A discussion of the design, the mode of action of the enzymatic level, and the metabolism of biochemical analogs. (Zenker.)

PHARM. CHEM. 399. Thesis Research in Pharmaceutical Chemistry. (Master's Level)
Credit determined by the amount and quality of work performed. (Staff.)

PHARM CHEM. 499. Dissertation Research in Pharmaceutical Chemistry. (Doctoral Level) (Staff.)

PHARMACOLOGY

Professors: Kinnard, and Ichniowski.
Assistant Professors: Blake, and Vick.

The Department of Pharmacology offers graduate programs leading to the Master of Science and Doctor of Philosophy degrees. The Department emphasizes the areas of cellular physiology, quantitative pharmacology, pharmacodynamics and biochemical pharmacology. 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 155, 156. General Pharmacology. (4, 5)
Three lectures, one laboratory first semester; four lectures, one laboratory second semester. Prerequisites, PHYSIOL 142, PHARM. CHEM .149 or consent of the instructor. A study of the pharmacology, toxicology, posology, untoward effects, precautions and therapeutic applications of medicinal substances. (Staff.)

PHARMACOLOGY 171. Official Methods of Biological Assay. (4)
First semester. Two lectures and two laboratory periods a week. Prerequisites, PHARMACOLOGY 155, 156. A study of the official methods of biological assay of the United States Pharmacopoeia and the National Formulary. (Staff.)

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 the 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. Prerequisites, 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: Blumster, Slama.

The Department of Pharmacognosy offers a graduate program leading to the Master of Science degree. 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 degree 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,

PHARMACOGNOSY 111, 113. A study of powdered vegetable drugs and spices from the structural and microchemical standpoints, including practice in identification and detection of adulterants. (Slama.)

PHARMACOGNOSY 211, 212. Advanced Pharmacognosy. (4, 4)
Two lectures and two laboratories. Prerequisites, PHARMACOGNOSY 111, 113. A study of many crude drugs not ordinarily studied in other pharmacognosy courses. Special attention will be given to practical problems and to the identification and detection of adulterants. (Slama.)

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.)

MICROBIOLOGY

Professor: Shay.
Assistant Professor: Krywolap and Schneider.

The Department of Microbiology serves both the School of Pharmacy and the School of Dentistry and offers programs leading to the degrees of Master of Science and Doctor of Philosophy. The student may specialize in the areas of pathogenic microbiology, fermentation microbiology, antibiotics, antiseptics, oral protozoa, immunology, mycology and transmission of infectious agents. For graduate study in microbiology, the student should have a degree in microbiology or pharmacy. Information regarding specific requirements for the degree may be obtained from the Department.

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.)

For Graduates

MICB 200, 201. Chemotherapy. (1, 1)
Alternate years. Prerequisites, MICB 121 or equivalent, BIOCHEM 111 or equivalent. Lectures which deal with the chemistry, toxicity, pharmacology and therapeutic value of drugs in the treatment of disease. (Shay.)

MICB 202. Theory and Principle of Reagents and Media. (3)
Offered in alternate years. Consideration of media or 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 micro-organisms. (Schneider.)

MICB 210. Special Problems in Microbiology.
Laboratory course. Special studies in the various divisions of microbiology. Credit determined by amount and quality of work performed. (Shay.)

MICB 211. Public Health. (2)
ities in the community and their relation to the practices of the health sciences Prerequisite, MICB 121 or equivalent. A demonstration of public health facil-

carried on through lectures and discussion groups. The application of statistical and epidemiological methods to health problems is illustrated through lectures and demonstration. (Shay.)

MICB 212. Bacterial Fermentations. (2)
Two lectures. (Given second semester in alternate years.) Prerequisite, BIOCHEM 111 or an equivalent course and MICB 121 or an equivalent course. 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. Research in Microbiology.
Credit determined by amount and quality of work performed. Open only to candidates for advanced degrees in microbiology. (Shay.)

MICB 281-283. Seminar. (1, 1)
Presentation and discussion of current literature and research in the field of microbiology. (Shay.)

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

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

SCHOOL OF SOCIAL WORK

Professors: Falck, Lansdale, Lewis, Siporin, Thursz, and Upham.
Associate Professors: Chaiklin, Trader, and Young.
Assistant Professors: Beschner, Brown, Buttrick, Callagy, Cole, Ephross, Frankel, Gavin, Gewisgold, Hersey, Hollander, Kahn, Kostick, Kraft, Levin, Makofsky, Moses, Moulton, Nucho, Pond, Pope, Simmons, Snyder, Taylor, Toia, Willis, and Wilson.
Instructors: Miller, and Novick.
Lecturers: Bateman, Blumberg, Cacace, Derbyshire, Granger, Hiller, Kaplan, Lisansky, McElhaney, McCall, Maxwell, Mittleman, Press, Price, and Weisgal.

For Graduates

THE SOCIAL SERVICES

SOWK 200, 201. Social Services and Social Policy. (2, 2)
Both semesters. Identification of social needs and analysis of social services with particular reference to political, social, and economic forces affecting their development. The social control and melioration functions of social welfare programs. Examination of the growth, organization and function of governmental and voluntary services. Open to qualified part-time students with consent of instructor. (Lansdale, Lewis, Miller, Young.)

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. (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. (Miller.)

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 problem. (McElhaney, Weisgal.)

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. (Lewis.)

GROWTH AND BEHAVIOR

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. (Lansdale.)

SOWK 210. Human Behavior I. (2)
First semester. Concepts basic to understanding adult social functioning with particular reference to characteristic ways of responding to stressful situations arising out of economic disadvantage, sociocultural conflict, illness and disability. Attention to the family as a social system and the social roles of family members in the patterning of relationships. (Mittleman, Upham, Trader.)

SOWK 211. Human Behavior II. (2)
Elaboration of concepts introduced in SOWK 210. Introduction of psychodynamic concepts used in assessment of psychosocial disorders.
(Mittelman, 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. (Upham.)

SOWK 213. Human Behavior IV. (2)
Second semester, second year. Concepts basic to an understanding of personality development in childhood and adolescence. Application of psychodynamic formulations in differential diagnosis and planning use of casework and groupwork techniques appropriate to the client's needs. Analysis of social work, sociological and biographical case materials utilizing psychosocial concepts.

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, neighborborhoods, 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, Derbyshire, Makofsky, Trader.)

SOCIAL WORK PRACTICE

SOWK 220, 221. Social Casework. (2, 2)
Both semesters, first year. Fundamental concepts and principles of the casework method. Emphasis on understanding person presenting the social problem, the environment, especially the family setting, in which it occurs, and the roles of the social agency and the social worker in using community resources in helpful ways. The relationship of study and history to psychosocial diagnosis and the formulation of appropriate treatment plans.
(Gavin, Gewisgold, McCall, Nucho, Siporin, Lewis.)

SOWK 222, 223. Social Casework. (2, 2)
Both semesters, second year. Further elaboration of basic concepts and introduction of more complex ideas. Case analysis directed toward development of skill in psychosocial diagnosis. Emphasis on selection of casework treatment techniques consistent with treatment objectives. Short-term and long-term casework treatment problems. Similarities and differences in casework practices in such varied settings as family and children's agencies, public assistance agencies, school social work departments, clinical (medical and psychiatric) services, correctional programs, etc. (Blumberg, Nucho, Siporin.)

SOWK 235. Group Methods in Social Work. (2)
Elementary concepts of social groupwork practice essential for the informed use of social groupwork resources in the community by social workers using casework methods. 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. (Brown, Beschner, Ephross, Falck, Kahn, Kraft.)

SOWK 240. Community Organization and Development. (2)
Basic concepts useful in facilitating citizen participation in neighborhood and community organization for social welfare. Analysis of methods used to achieve social objectives in community provision of needed services and prevention and control of psychosocial disorders. (Beschner, Levin, Simmons.)

SOWK 241. Community Organization in Neighborhoods. (2)
Continuation of SOWK 240 for students in C. O. concentration. Emphasis on neighborhood social work. (Simmons, Cole.)

SOWK 242, 243. Community Organization Methods. (2, 2)
(Both semesters, second year.) Elaboration of basic concepts and methods of application. The role of the social worker in developing leadership and enabling neighborhood groups to identify and solve problems. Emphasis upon community organization process in intergroup relations in urban renewal, housing and settlement situations. (Makofsky, Moses, Thursz.)

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.
(Bateman, Frankel, Hiller, Lansdale.)

SOWK 260. Social Investigation. (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, Sterne.)

SOWK 261, 262. Social Work Research. (2, 2)
Both semesters, second year. Analysis of significant social work studies and related social science research. A research report of substantial dimensions and high standards, presenting and analyzing findings of a study of some professional problem is required. (Chaiklin, Sterne.)

SOWK 280, 281. Field Work: Basic Social Casework. (4, 4)
Both semesters, first year. Placement in community agencies for practice instruction in social casework method. (Brown, Callagy, Gavin, Hersey, Hollander, Kostick, Kraft, Moulton, Pope, Snyder, Taylor, Willis and Staff.)

SOWK 282, 283. Field Work: Advanced Social Casework. (6, 4)
Both semesters, second year. Placement in community agencies for practice instruction in social casework method. (Brown, Callagy, Gavin, Hersey, Hollander, Kostick, Kraft, Moulton, Pope, Snyder, Taylor, Willis and Staff.)

SOWK 285, 286. Field Work: Community Organization and Neighborhood Development. (4, 4)
Both semesters, first year. Placement in community agencies for practice instruction in community organization method.
(Beschner, Cole, Frankel, Kahn, Makofsky, Moses, Simmons, Wilson.)

SOWK 287, 288. Field Work: Community Organization. (5, 5)
Both semesters, second year. Placement in community agencies for practice instruction in community organization method.
(Beschner, Cole, Frankel, Kahn, Makofsky, Moses, Simmons, Wilson.)

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. (Falk, Granger, Lisansky, McCall, Press, Buttrick, Makofsky, Siporin, Beschner.)

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., Associate Dean of the Graduate School

Appointed Members

ATCHISON, William F., Ph.D., Professor of Computer Science 1971
MANNING, Charles, Ph.D., Dean of College of Arts and Sciences 1972
MITCHELL, T. Faye, M.A., Professor of Home Economics 1969
SCHAMP, Homer W., Ph.D., Dean of the Faculty, UMBC 1970

Elected Members

BICKLEY, William E., Ph.D., Professor of Entomology 1970
BURGISON, Raymond M., Ph.D., Professor of Pharmacology (Baltimore) .. 1972
CARDOZIER, V. R., Ph.D., Professor of Agricultural and Extension Education 1969
DILLARD, Dudley, Ph.D., Professor of Economics 1971
GAUCH, Hugh E., Ph.D., Professor of Botany 1969
HARRISON, Horace V., Ph.D., Professor of Government and Politics 1969
LASTER, Howard J., Ph.D., Professor of Physics and Astronomy 1969
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

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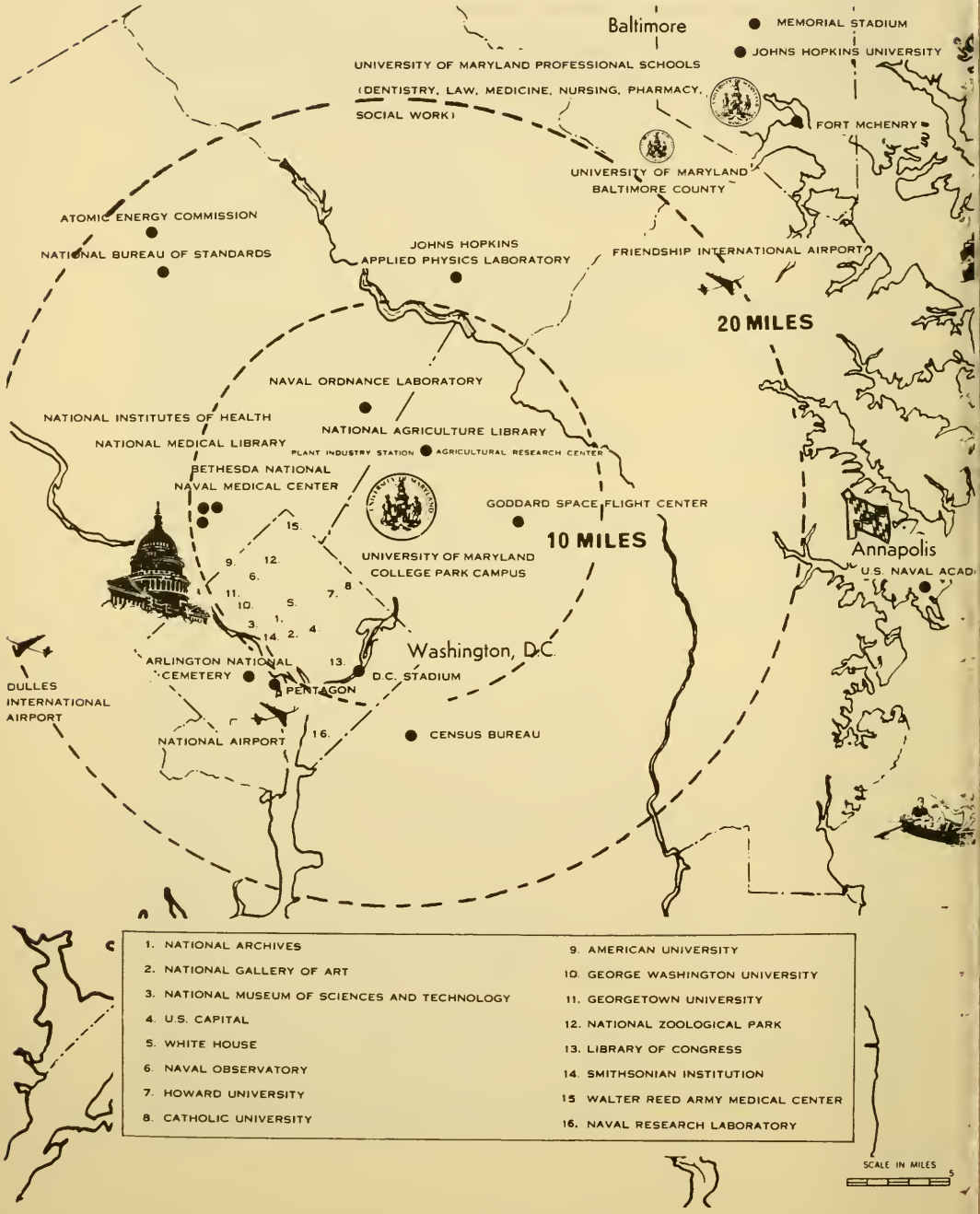
The University of Maryland — Academic Resources and Points of Interest



1. NATIONAL ARCHIVES
2. NATIONAL GALLERY OF ART
3. NATIONAL MUSEUM OF SCIENCES AND TECHNOLOGY
4. U.S. CAPITAL
5. WHITE HOUSE
6. NAVAL OBSERVATORY
7. HOWARD UNIVERSITY
8. CATHOLIC UNIVERSITY
9. AMERICAN UNIVERSITY
10. GEORGE WASHINGTON UNIVERSITY
11. GEORGETOWN UNIVERSITY
12. NATIONAL ZOOLOGICAL PARK
13. LIBRARY OF CONGRESS
14. SMITHSONIAN INSTITUTION
15. WALTER REED ARMY MEDICAL CENTER
16. NAVAL RESEARCH LABORATORY

THE UNIVERSITY is the rear guard and the advance agent of society. It lives in the past, the present and the future. It is the storehouse of knowledge; it draws upon this depository to throw light upon the present; it prepares people to live and make a living in the world of today; and it should take the lead in expanding the intellectual horizons and the scientific frontiers, thus helping mankind to go forward —always toward the promise of a better tomorrow.

From "The State and the University"
the inaugural address of
President Wilson H. Elkins
January 20, 1955
College Park, Maryland